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## 01 COAL AND COAL PRODUCTS

### 001 Alcohols and Coal-based Liquid Fuels for Automotive and Stationary Diesel Engines.

Deals with the research in progress at the University of Trieste on the use of alternative fuels in Diesel engines. Tests have been made on methanol and ethanol among alcohols, SRC-II and COED among coal-based liquid fuels; their main characteristics, particularly the possibility to increase inflammability, have been carefully taken under examination. The influence of these fuels on performances of various types of engines has been evaluated in comparison with diesel fuel standard operation.

Giadrossi, Alessandro

Int. J. Energy Systems 5,2;1985;76-81(6p)

### 002 Developing Coal in Developing Countries.

A number of developing countries have substantial coal reserves but have had difficulties with restructuring energy consumption patterns, transportation and supply bottlenecks. Consequently these governments have allowed multinational corporations to exploit their reserves for export. The host countries must have a detailed understanding of cost and revenue sharing arrangements. Environmental, social and health impacts may effectively externalize costs and must be taken into consideration when planning for the development of coal reserves.

Chadwick, Michael and others

Ambio 14,4-5;1985;249-252(4p)

### 003 Returns to Scale in U.S. Surface Mining of Coal

A parametric class of ray homothetic production functions that can be estimated with the ordinary least squares method has been introduced in order to study returns to scale and optimal scale in U.S. surface mining of coal. For each of the state-wide representative mines, both the returns to scale and optimal output level corresponding to its current output mix has been calculated, based on the estimated production function.

Fare, Rolf and Yoon, Bong

Resources and Energy 7,4; December 1985; 341-352 (12p)

### 004 Some Considerations of Start Up in the Design of Fluidized Bed Boilers.

Describes an auxiliary start-up system as required in fluidized bed combustors in order to heat the bed to a temperature at which coal fed to the bed will ignite and burn without producing excessive smoke. To illustrate the nature of the design calculations associated with start-up, the paper describes the principles of a mathematical model developed to determine the rating of burner required for the hot gas start-up, approach.

Moodie, J and Vickers, M.A.

Energy Research 9,2; Apr-June 1985;203-209(7p)

**005 Synthesis Gas and Hydrogen Production from Solar Gasification of Albertan Coal.**

An assessment is carried out on the possibility of using various combinations of solar-powered coal-gasification plants in the Canadian coalfields. Solar coal gasification processes are studied and various processes are developed at the conceptual level. An economic assessment is carried out using the methodologies of the chemical industry.

Baykara, S. Z. and Bilgen, E.

Energy Convers. Mgmt. 25,4;1985; 391-398(8p)

**02 PETROLEUM**

**006 Changing Pattern of Third-World Oil Supplies.**

The changing pattern of the OIDC's oil supplies has closely paralleled the transformation of the structure of the international oil market. The semi-industrial OIDC's have gained an entry into the oil market, enabling them to assume an active role in securing their oil requirements directly, without the mediation of major oil companies. Information on OIDC's oil imports and the changes in them are obtained from IEDC's Tanker Tracking Information System. A number of tables and graphs concerning the volume and origin of oil imports of some major OIDCs are included in this paper.

Karbassioun, Bahman

OPEC Review 9, 3; Autumn 1985; 267-285(19p).

**007 Is the Spot Market for Oil Products Efficient? : Some Rotterdam Evidence**

This paper presents evidence relating to the efficiency of the Rotterdam market for oil products. Analysis of daily, weekly and monthly price changes for gas oil during the period 1978-83 results in the rejection of the efficiency hypothesis, i.e., relative price changes have been serially dependent. On the basis of this observation, a very simple trading rule is developed. This rule is tested out, simulating market transactions during the first two quarters of 1984. The financial outcome of this game turns out to be rewarding

Gjolberg,Ole

Energy Economics 7,4;October 1985;231-235 (5p)

008 Third World Perspective on Petroleum.

The various aspects and implications of the petroleum and petroleum-related scene in the Third World net exporting countries (OPEC and non-OPEC alike) have been discussed in depth. The petroleum potential, exploration activities and the problems and future programmes of the petroleum-importing developing countries (PIDCs) have also been discussed.

Zakariya, Hasan S.

OPEC Review 9,3; Autumn 1985;243-265(23p)

08 HYDROGEN

009 Characteristics of Hydrogen-Fueled Gas Turbine Cycle with Intercooler, Hydrogen Turbine and Hydrogen Heater.

The performance of a hydrogen fueled gas turbine cycle equipped with an intercooler, regenerator, hydrogen turbine and recuperative hydrogen heater are analyzed. The intercooler is very effective to prevent the condensation and freezing of water vapor in cooling the suction air. The operation of hydrogen turbine in low-temperature range can also be prevented by adopting hydrogen heater. Thermodynamic analysis has revealed that the thermal efficiency and the specific output are considerably improved compared to those of the simple gas turbine cycle.

Tsujikawa, Y and Sawada, T

Int J Hydrogen Energy 10,10;1985;677-683(7p)

010 Chemical Synthetic Methods and Hydrogen Storage Properties of Intermetallic Compound

In this experiment, a series of chemical methods for the synthesis of powdered hydrogen storage intermetallic compounds were investigated and the properties of so prepared alloys were characterized by various methods.

Shen, Panwen and others

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July, 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3,1303-1307(5p)

011 Coated Silica Shells: An Advanced Hydrogen Storage System.

Preliminary investigation of a new concept which consists of storing hydrogen on a bed of small metal-coated spherical shells of nearly pure silica composition. The silica shells function primarily as high pressure containers, which because of silica's high strength, can withstand the pressures required to achieve significant storage densities. Since pure silica is too permeable to adequately retain hydrogen, a metal (eg.Ni,Cu,Mo) coating is added as a room temperature permeation barrier. The rate at which hydrogen permeates these metals varies rapidly with temperature. Consequently, to cause the hydrogen to readily permeate the metal coating as well as the Silica Shell

requires heating the bed to only moderate temperatures.

Henderson, Timothy M.

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1415-1418(4p)

## 12 Energy Conversion Process with Coal and Sulphuric Acid.

In this process, the coal reacts with an oxygen containing substance such as sulphuric acid or metal oxides. Subsequently, this substance is reoxidised with oxygen. The products of the two step combustion process are hydrogen and electric power which are generated by expanding the gaseous products of the high pressure combustion in a gas turbine.

Knoche, KF and others

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1135-1143(9p)

## 13 Hydrogen Absorption - Desorption Characteristics of Zr (Fe(x)Cr(1-x))(2).

A number of potential hydrogen compounds, namely Zr(Fe(x)Cr(1-x))(2) have been investigated. All alloys studied are predominantly hexagonal Laves phases, with lattice parameters decreasing as 'x' increases. An additional, unidentified phase is observed, increasing in quantity as chromium levels increase. These pseudobinaries absorb hydrogen readily without prior activation, with the exception of Zr(Fe(0.25)Cr(0.75))(2) which is believed to have been poisoned by oxygen occlusion during alloy preparation. P-C-T curves have been measured and thermodynamic quantities determined for Zr(Fe(0.75)Cr(0.25))(2) - H(2) and Zr(Fe(0.70)Cr(0.30))(2) - H(2) systems.

Ivey, DG and Northwood, DO.

Hydrogen Energy Progress V : Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1395-1404(10p)

## 114 Hydrogen Compression by Metal Hydrides

Discusses the principles of hydrogen compression using a metal hydride. Experimental results pertinent to the compressor application are presented for vanadium-rich vanadium-titanium-iron alloy hydrides. Comparison with LaNi(5)H(2) reveals an improvement in the compression ratio.

Lynch, JF and others

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by TN Veziroglu and J B Taylor, New York, Pergamon Press, 1984, v3, 1329-1337(11p)

## 015 Hydrogen Production by Solar Thermoysis of Water.

Hydrogen production by water thermoysis using solar energy is studied for reactor temperatures of 1500-2500K and pressures of 50-1000 KPa. Separation of hydrogen from the product gases is affected at low temperature via a diffusion-membrane process. Results of simulation and optimisation of a process with a hydrogen production capacity of about 600 GJ per year are presented. Processes with reactors operating at high temperatures and low pressures proved to be thermodynamically more efficient and also more possible with regard to solar energy utilization.

Baykara, SZ and Bilgen, E

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1111-1122 (12p)

## 016 Hydrogen Solubility in Mg(2) Ni.

Magnesium nickel hydride is a promising candidate for hydrogen storage. The authors report the hydrogen solubility in Mg(2) Ni and lattice parameter change by hydrogen solubility at 300 C, 355 C and 400 C. From these data the unit cell size change vs hydrogen content and thermodynamic values of solution have been obtained.

Ono, S and others

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1405-1413 (9p)

## 017 Photocatalytic Decomposition of Methanol on fine Nickel and Cobalt particle

Photocatalytic decomposition of methanol was studied over titanium di-oxide-supported nickel and cobalt catalysts, varying the sizes of metal particles from 100 to 300 A for nickel and from 50 to 500A for cobalt, respectively. The rate of methanol decomposition was estimated from that of hydrogen evolution and the highest rate was observed when the particle sizes of nickel and cobalt were 170 and 100A, respectively. In the present work, titanium tetra-iso-propoxide and the metal nitrates dissolved in ethylene glycol were used to control the metal particles in an even size level, measured by transmission electron microscopy.

Tsuiki, H and others

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1027-1037 (11p)

## 018 Photoelectrochemical Hydrogen Evolution Using Amorphous Silicon Electrodes having p-i-n Or p-i-n-p-i-n Junctions.

The performances of Photoelectrochemical cells and amorphous silicon

solid photocells, using p-i-n junction a-Si films prepared under the same conditions, were studied in order to compare the properties of the a-Si PEC cells and those of the solid a-Si photocells. The feasibility of decomposition of water was also examined by using p-i-n-p-i-n (tandem) electrodes.

Matsumura, Michio and others

Solar Energy Materials 13,1;Jan 1986; 57-64(8p)

**019 Recent Development of Hydride Energy Systems in Japan.**

Describes the present status of the Japanese developments of the metal hydride energy conversion systems. Metal hydride reactions applied for cyclic uses will also be correlated with various hydride properties, operating modes and cost-effectiveness standpoints.

Suda, S

Hydrogen Energy Progress VI: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1201-1211 (11p)

**020 Solar Photolysis of Water - How Efficient and how Economic?**

A summary analysis of the thermodynamic limits on the conversion efficiency of solar water photolysis schemes is presented. It is shown that dual photosystem schemes have a decided advantage over single photosystem schemes. Even when several non-ideal factors are considered, the dual system seems possible to achieve over 15% efficiency as opposed to 10% for single photosystem schemes. Finally, some fundamental concepts are presented which should be considered in any economic analysis of solar water photolysis systems.

Bolton, James R.

Hydrogen Energy Progress VI: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984 edited by T N Veziroglu and J B Taylor, New York, Pergamon Press, 1984, v3, 949-955(7p)

**021 Solar Reactor for High-Temperature Gas Phase Reactions (Water and Carbon Dioxide Thermolysis and Nitric Oxide Synthesis)**

This paper deals with an original way for carrying out highly endothermic reactions at high temperature under concentrated radiant energy. Three examples of chemical reactions were chosen : thermal direct decompositions of water and of carbon-dioxide and synthesis of nitric oxide from air. An experimental study consisting of a "dissociation reactor" located at the focus of either an image furnace or a solar concentrator, and a quenching device in which the hot gases are quickly cooled by mixing with turbulent gas jets is described.

Lapicoue, F, and others.

Solar Energy 35,2;1985;153-166(14p)

## 022 Solar Thermochemical Hydrogen: The Heat Source-Process Interface.

A discussion of issues and considerations related to the interface between a solar heat source and a thermochemical hydrogen process and some details of a tubular heat exchanger operating as such include the temperature-heat input requirements for the endothermic reaction, type of receiver, heat storage, transient operations, and control. A thermal performance analysis of a tubular reactor/heat exchanger operating in a cavity type solar receiver is applied to  $SO_3$  decomposition. The analysis produces axial distributions of temperature - tube wall and process fluid, reaction rate, conversion, velocity, density, pressure and residence time.

Funk, JE and England, C

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by TN Veziroglu and J B Taylor, New York, Pergamon Press, 1984, v3, 1101-1109(9p)

## 023 Solar Thermochemical Process. Interface Study.

Many thermochemical or thermochemical/ electrochemical hybrid hydrogen production processes involve a step of high temperature decomposition of sulfuric acid. Three cases of coupling the sulfuric acid vaporization and decomposition processes to a solar heat source have been studied. A separate case which uses helium as a heat transport medium to decouple the acid decomposition from the solar heat source is also included for comparison. The process flowsheet and state points for each case are presented. The conceptual design and sizing for the receiver/reactor are included. The fabrication methods for the silicon carbide components are also discussed.

Lin, SS and others

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 1123-1133(11p)

## 024 Splitting Water with Semiconducting Photoelectrodes - Efficiency Considerations.

An efficiency analysis of photoelectrolysis solar-cells is presented which takes into account fundamental thermodynamic energy losses, as well as all major losses associated with charge transport in semiconductor photoelectrochemical cells (PEC's). A one-photon PEC is found to have an "upper limit" efficiency of 7% (AM 1.2 solar energy to chemical potential energy stored as H<sub>2</sub>). For two-photon configurations the "upper limit" for a p-n PEC is 10% while for a tandem PEC it is 18%.

Weber, Michael F and Dignam, Michael J

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto, 15-20 July 1984, edited by T.N. Veziroglu and J.B. Taylor, New York, Pergamon Press, 1984, v3, 957-968 (12p)

**025 Biogas : will it ever take off?**

The potential of biogas to alleviate pressing problems in developing countries, especially regarding small-scale rural applications. The current problems and bottle-necks preventing this technology reaching its maximum potential and the strategies necessary in order to mitigate these problems are the topics of discussion.

Stuckey, David D.

Appropriate Technology 12,2; September 1985;27-29(3p)

**026 Biomass Gasifiers for Energy Supply to Agriculture and Small Industry.**

Biomass gasifiers may be an important energy alternative for agriculture and small industry in developing countries. They will be more economical than diesel only where the annual operating times are long and the load factor high, unless diesel fuel is very costly. Biomass gasification can be important where the use of small engines to provide mechanical or electrical energy is not economically feasible because of high transportation costs for petroleum fuels or a shortage of foreign currency. Local manufacturing is the most reasonable basis for large scale introduction of biomass gasification in developing countries. There are several obstacles to the introduction of gasifiers, but they can be overcome.

Kjellstrom, Bjorn

Ambio 14,4-5;1985;267-274(8p)

**027 Biomass Production and Nutrient Accumulation in Seedling and Coppice Hardwood Plantations.**

Total biomass and contents of N, P, Ca, Mg and Mn in above ground tree components of five deciduous species were determined in closely spaced (0.9 x 0.6m) 5-year-old plantations of seedling origin and 5-year-old coppice stands regenerated after the seedling harvest. The proportion of total biomass in bole components increased and in crown components decreased in coppice stands as compared to seedling stands. This resulted in relatively more Ca and less N, P, and K in above-ground tree components of the coppice stands.

Withner, R.F and Stringer, J.W.

Forest Ecology and Management 13,3&4; December 1985; 223-233(11p)

**028 Biosensors: Recent Trends.**

One of the major bottlenecks in automation and process control of industrial bioprocesses is the lack of suitable sensing devices to accurately measure the concentrations of biomolecules. This paper

reviews recent approaches toward the development of biosensors which involve a biochemical interaction to measure the concentration of biomolecules, primarily for the on-line monitoring and control of fermentation processes.

Graham, A and Moo Young, M.

Biotech Adv . 3,2;1985;209-218 (10p)

#### 029 Biotechnological Applications of Plant Cells in Culture.

For many workers, the most exciting recent advances in the realm of plant cell biotechnology, center on results obtained from experiments concerned with the genetic engineering of plant cells. Various groups of workers have managed to introduce new genetic material into plant cells, using Ti-plasmids (or modified Ti-plasmids) from Agro bacterium tumefaciens. This genetic material has been expressed (with varying degrees of efficiency), in each case. Thus the way may possibly become clear to produce plant cell cultures or whole plants with entirely new or novel properties.

Other areas in which progress has been made are in the design of media conditions to promote secondary product formation, and in ways of immobilizing plant cells and enzymes to achieve efficient secondary product formation.

Shargool, Peter D

Biotech Adv 3,1;1985;29-38(10p)

#### 030 Cotton Stalks as an Energy Source for Nicaragua.

Cotton, a major crop in Nicaragua generates cotton stalks as a residue of its harvest. The stalks, after being harvested and stored in chip form, can be compacted into pellets or briquettes. The fuel can then be used by individuals commerce and industry and appears to be an economically feasible energy alternative for Nicaragua.

Svenningsson, Per Johan.

Ambio 14,4-5;1985; 298-303 (6p)

#### 031 Ethanol Fuel from Sugarcane in Brazil.

In November 1975 Brazil initiated a program to raise the production of ethanol from sugarcane and increase the use of ethanol as a substitute for gasoline. Although the Brazilian alcohol program stands out as one of the most significant accomplishments, important aspects of the ethanol program are controversial in both Brazil and other countries. This article analyzes some of the controversial issues by reviewing up-to-date primary data and secondary studies available in Brazil. In particular, the issues of "food vs fuel", economics, employment and energetics are addressed. Some important trends, innovative developments and policy issues that are occurring as part of the Brazilian experience with alcohol fuel are also discussed.

Geller, Howard S.

Ann. Rev. Energy 10; 1985;135-164 (30p)

**032 Ethanol Fuel: Biomass Energy in Brazil**

Brazil has a history of producing ethanol from sugarcane, a primary crop. Recent technological advances have enabled the ethanol program in Brazil to achieve substantial progress. An analysis of ethanol production costs shows that the process has been relatively cost-efficient.

Goldemberg, J and others.

Ambio 14,4-5;1985;293-297(5p)

**033 Euphorbia lathyris L. as a Potential Crop Plant. An Outline.**

The distribution, botany and history of Euphorbia lathyris L., caper spurge or gopher plant has been outlined. Special consideration is given to the chemical evaluation in respect to seed oil and whole-plant extractable. Seed oil content proved to be very high and its fatty acid composition is unique because of the dominating role of oleic acid. Despite its adaptability to arid environments the plants of E. lathyris exhibit more vigour and therefore produce more biomass per hectare when grown under normal agricultural conditions.

Hondelmann; Walter and Radatz, Wolfgang.

Angew. Botanik 57; 1983; 349-362 (14p).

**034 Fuel Production from a Brewery Residue.**

The anaerobic digestion of the draff, a residue from the industrial conversion of malt in brewery has been studied. The experimental anaerobic digestion of bovine and horse manures was performed under similar conditions for comparative purposes. The results obtained are reported and discussed. Different experimental parameters, which seem to affect the process yield, have been investigated. The draff is shown to be a valuable potential fuel source.

Tshiteya, Mukuna

Energy 10,12;1985;1299-1306 (8p)

**035 Fuels and Industrial Chemicals through Biotechnology 2.**

Subjects of major interest of research in 1983-84 have been ethanol fermentation, biotechnical production of 2,3,-butanediol and of a number of organic and amino acids. A few examples of the application of biocatalysis for the production of speciality chemicals have been discussed in this paper. The construction of a two 10KL bed-volume immobilized yeast bioreactors at the Kyowa Hakko Kogyo Company Hofu plant, the announcement by Nitto Chemical Industries Company to begin the biotechnical production of acrylamide, and the French decision to construct pilot plants for the biotechnical production of acetone-butanol-ethanol cosolvent

and of ethanol from renewable sources represent major scale-up developments.

Linko, P

Biotech Adv. 3,1;1985;39-63(25p)

**036 Hydrocarbons from *Calotropis procera* in Northern Australia.**

A survey has been undertaken of the yield of cyclohexane-extractable compounds ('biocrude') from natural stands of *Calotropis procera* from 39 sampling sites in northern Australia. A mean yield of 4.82% 'biocrude' (on a dry weight basis) was obtained from sites in north Queensland. There was no evidence of marked seasonal variations in yield of 'biocrude' and no variations related to soil type.

Carruthers, I.B. and others.

Biomass 4; 1984; 275-282 (8p).

**037 Immobilization of a Syntrophic Culture of Propionate - Degrading and Methanogenic Bacteria Present in Cellulose-Enriched Culture.**

A simple technique for the immobilization of propionate-utilizing bacteria in syntrophic association with methanogens was developed. The results suggest that the immobilization of this syntrophic culture retained practically all of the slow-growing group of anaerobes involved in the conversion of short chain volatile fatty acids to methane, a rate limiting step in methanogenic fermentations.

Khan, A.W. and Meek, Erin.

Biomass 8,3;1985;195-204(10p)

**038 Improved Wood Burning Cookstoves: Signs of Success.**

Recent improvements in the energy efficiency of fuelwood cookstoves have resulted from the application of principles of combustion and heat transfer, standardized testing, advanced production engineering techniques, and the systematic analysis of user feed-back. Issues of quality control in large scale production, stove durability and lifetime, health and safety impacts and the effectiveness of different dissemination strategies require additional research and analysis.

Baldwin, Sam and others

Ambio 14,4-5;1985;280-287 (8p)

**039 Influence of Substrate Composition on Biogas Yields of Methanogenic Digesters.**

A series of ordinary least squares regression models relating biogas yields to various substrate constituents was generated and evaluated using a computer statistical analysis system (SAS). The results indicate that models using soluble carbohydrate content, or combined carbohydrate and protein content, are most suitable for predicting

the biogas production of a substrate. Analyses of biochemical change of substrate constituents during digestion also indicate that carbohydrate and protein are the primary components utilized during digestion.

Habig, Clifford

Biomass 8,4;1985;245-253(9p)

**040 Mathematical Model for Ethanol Production by Extractive.**

**Fermentation in a Continuous Stirred Tank Fermentor**

The ethanol fermentation has been examined as a model system for end product inhibition and extractive fermentation and a computer model has been developed predicting the productivity enhancement possible with this technique together with other key parameters such as extraction efficiency and residual glucose concentration. The model predicts a total ethanol productivity of 82.6g/Lh if a glucose feed of 750g/L is fermented with a solvent having a distribution coefficient of 0.5 at a solvent dilution rate of 5.0 per hour. This is more than 10 times higher than for a conventional chemostat fermentation of a 250g/L glucose feed.

Kollerup, Finn and Dagulis, Andrew J

Biotechnology & Bioengineering 27,9; September 1985; 1335-1346(12p)

**041 Power from Producer Gas in Developing Countries.**

The use of producer gas (from the thermal gasification of biomass) to provide mechanical and electrical power has been described. The producer gas applications, system design problems and economic problems have been discussed.

Mahin, Dean B

Appropriate Technology 2,2; September 1985; 12-13 (2p)

**042 Resinous Plants as an Economic Alternative to Bioenergy Plantations.**

The purpose of this paper is to examine the economics of bioenergy production in arid lands and to explore the feasibility of using resin-producing desert plants as sources of speciality or commodity chemicals. Analysis indicate that bioenergy production in arid lands must be integrated with the generation of higher-priced chemical commodities such as naval stores resin.

Hoffmann, Joseph J.

Energy 10,10;1985;1139-1143 (5p)

**043 Small Steam Systems for the Third World.**

Steam and sterling engines are two of the technologies that can convert biomass fuels into energy. This article explains why ITDG believes steam has a great potential in developing countries and describes the small-scale system being developed. A brief note on

why stirling engines in their present state of development do not appear to have great potential has been presented.

Hislop, Drummond

Appropriate Technology 12,2; September 1985;17-19(3p)

**044 Solid-State Ethanol Fermentation by Means of Inert Gas Circulation.**

A new method for solid-state ethanol fermentation was experimented for the ethanol production from solid starchy materials, where a packed-bed-type fermentor was used. Ethanol production was set in by a form of parallel fermentation using a respiration-deficient mutant of *Saccharomyces cerevilliae*. Produced ethanol was simultaneously stripped by circulating inert gas and separated in a condenser. The fermentation efficiency was about 80% which was evaluated much higher than those of conventional solid-state fermentations.

Sato, K and others

Biotechnology & Bioengineering 27,9; September 1985;1312-1319(8p)

**045 Thermophilic Anaerobic Digestion of High Strength Wastewaters.**

Studies the thermophilic digestion of vinasse as an example of a high-strength wastewater in reactors with a high biomass retention. Investigates the performance of mixed digesters with a high liquid and biomass retention time, and of reactors with a low liquid but a high biomass retention time. Experiments with (semi) continuously fed digesters can provide information about the effluent quality at high liquid and biomass retention times as a function of the influent concentration and the digestion temperature. This information will be indicative for the effluent quality of reactors with a high biomass and a low liquid retention time.

Wiegant, WM and others

Biotechnology & Bioengineering 27,9; September 1985;1374-1381(8p)

**046 Two phase Thermophilic Anaerobic Digestion of Screened Dairy Manure.**

Thermophilic anaerobic digestion (55 C) was studied using screened dairy manure as feed substrate. The results indicated that satisfactory high-rate thermophilic digestion could be obtained at short hydraulic retention times for both one-and two-phase systems. There was no marked difference in performance between mesophilic and thermophilic temperatures in acid-phase reactor.

Liao, P.H. and Lo, K.V.

Biomass 8,3;1985;185-194 (10p)

**047 Use of Agricultural Residue as Fuel.**

Animal dung and crop residues form a major biomass resource in many developing countries. As wood-fuel supplies are depleted, these agricultural residues are increasingly being diverted for use as domestic fuels. This article examines the implications of this shift, focusing particularly on the possible negative impact on the soil due to reduced organic recycling.

Barnard, Geoffrey W.

Ambio 14,4-5;1985;259-266 (8p)

**048 Wood-Fuel and Conventional Fuel Demands in the Developing World.**

This paper examines some of the factors influencing the evolution of conventional fuel and wood fuel demands in the developing world. It shows that the resource and balance-of-payments constraints against the use of conventional fuels are less than commonly assumed. It examines the dynamics of wood-fuel resource depletion and discusses the problems of estimating the future demand for wood fuel. The need for a disaggregated analysis that takes into account the differences between categories of domestic fuel consumers is emphasized.

Foley, Gerald

Ambio 14,4-5;1985;253-258 (6p)

## 13 HYDRO ENERGY

**049 Geotextile Applications in Dam Construction.**

The particular advantage of geotextile filters is that during manufacture their filtration characteristics may be tailored precisely to the requirements at the site. Other advantages include their greater ease of laying and consistent quality when compared with traditional materials. Some recent applications are described.

Water Power and Dam Construction 37,12;December 1985;22-23(2p)

**050 Use of Geomembranes for Emergency Spillways.**

The advantage of installing a membrane-lined emergency spilling as a lower cost alternative to conventional concrete-lined or rock-lined compacted earth spillways is described. Field studies on the behaviour of a flexible membrane for this application are described.

Timbin, L.O.

Water Power and Dam Construction 37,12; December 1985;19-21(3p)

## 14 SOLAR ENERGY

### Photovoltaics

#### 051 Capacitance Measurements of Cu(2)S-Zn(x)Cd(1-x)S Solar Cells.

Zinc diffusion from  $Zn(x)Cd(1-x)S$  into  $Cu(2)S$  during the topotaxial formation of the layer and heat treatment of  $Cu(2)S-Zn(x)Cd(1-x)S$  solar cells and Cu diffusion from  $Cu(2)S$  into  $Zn(x)Cd(1-x)S$  during heat treatment of the cells caused a redistribution of the space charge and potential of the heterojunction. The effect of this redistribution and of the density of the interface states on the capacity of the  $Cu(2)S-Zn(x)Cd(1-x)S$  heterojunction was studied. This study shows that the Zn diffusion into  $Cu(2)S$  leads to a compensated layer and thus to an enlargement of the band bending in the  $Cu(2)S$  side.

Gordillo, Gerardo

Solar Energy Materials 13, 1; Jan 1986; 37-46(10p)

#### 052 Costs of Controlling Environmental Emissions from the Manufacture of Silicon Dendritic Web Photovoltaic Cells.

The annual incremental environmental control costs, based on capital recovery over a ten-year plant life are estimated for integrated and disaggregated plant designs respectively. Capital costs ranged from 50-55% (integrated) and 36-40% (disaggregated) of the estimated costs. Total control costs are small in comparison with current production costs for silicon photovoltaic devices (app \$5/Wp) but will be of greater importance at projected production cost of \$0.5/Wp - \$1.0/Wp. These conclusions are specific to the material and process options examined.

Wilenitz, I and others

Solar Cells 15,3; November 1985; 247-266(20p)

#### 053 Crystal Growth of Cadmium Selenide by Fused Salt Electrolysis and its Photoelectrochemical Properties.

The electrodeposition of CdSe crystals has been examined under potentiostatic condition on graphite electrodes in  $LiCl-KCl$  melts containing  $CdCl(2)$  and  $Na(2)SeO(3)$ . Deposits with various morphologies, needle-like, hollow-like, dendritic and columnar crystals, have been obtained by controlling the deposition potential. These as-grown deposits have fairly good photoelectrochemical characteristics and photoelectrochemical cells with a maximum conversion efficiency of 6.1% under white light illumination of  $37mW/cm(2)$  were constructed using a CdSe photoanode.

Minoura, H and others.

Solar Energy Materials 12,5; November 1985; 335-344(10p)

054 Effect of a Defective BSF layer on Solar Cell Open Circuit Voltage.

A straightforward analysis of special limiting cases has permitted the determination of the range of possible open circuit voltage losses due to a defective BSF layer. An important result of the analysis is the finding that it is possible to have a fully effective BSF (Back Surface field) region, regardless of the spatial distribution of the defective areas, as long as the total defective area is reduced below certain limits. Distributed defects were found to be much more harmful than lumped defects.

Weizer, Victor G

Solar Cells 14,3; July 1985;241-249 (8p)

055 Elementary Degradation Mechanisms of Hetero-Converters of Cu(2)S-CdS Type.

A brief analysis of the degradation mechanisms of Cu(2)S-CdS heteroconverters is given. The conditions under which various degradation mechanisms are observed and the methods of developing stable solar elements on the basis of A(2)B(6) materials are given.

Torchinskaya, T.U.

Applied Solar Energy (Geliotekhnika) 20,5;1984;14-18(5p)

056 High Efficiency GaAlAs-GaAs Photoconvertors with Two Sided Sensitivity.

Photoconverters with two sided sensitivity were manufactured by capillary liquid epitaxy. This, two sided photoconverter, in contrast to a photodiode, converts a variable light flux into voltage with an additional voltage source. A two sided photoconverter can be used for measuring illumination intensity and in automatic circuit.

Bardina, N. M. and others.

Applied Solar Energy (Geliotekhnika) 21,1;1984;1-5(5p)

057 Incoherent - Light Induced Diffusion of Phosphorus as a Doping Procedure for Low-Cost Silicon Solar Cells..

Diffusion of phosphorus into p-type silicon from spun on phosphoro-silica films has been induced by means of incoherent light from a xero arc-lamp. A suitable process for solar cell preparation appears to be heating for 20s to 1000 C followed by gradual cooling. Doping profiles measured by the Hall effect exhibit a maximum concentration of  $2-3 \times 10^{19}$  cm<sup>-3</sup> at the silicon surface and a junction depth of about 1500 Å. A number of test-cell batches have been prepared from single-as well as polycrystalline material and very favourable and reproducible spectral-response characteristics have been found. In spite of the non-optimized cell design and a rather primitive antireflective coating, AM1 efficiencies upto 12.7% (single-crystal cell) and 8.2% (polycrystalline cell) have been recorded.

Larsen, Nylandsted, A and Nielsen, Drud L

Solar Cells 15,3; November 1985; 239-245(7p)

**058 Model of Silicon Solar Cells for Concentrator Photovoltaic and Photovoltaic/Thermal System Design.**

Semi-empirical expressions are presented for open-circuit voltage, short-circuit voltage, fill factor and conversion efficiency of silicon solar cells as explicit functions of optical concentration (C) and temperature (T). In addition similar expressions are given for the solar cell current as a function of C and T and of the operating voltage V, to enable characterization under conditions of nonoptimal power transfer. The agreement of the model with experimental data is shown to be within 10% for all parameters. An example of an application of the model to system design is also presented.

Mbewe, D. J and others.

Solar Energy 35,3; 1985; 247-258 (12p)

**059 Performance of n+-p-p- Silicon Cells fabricated through masked ion implantation.**

Focuses on the performance of back-surface-field (BSF) Silicon solar cells, whose front n(+) - p junctions were obtained by means of masked ion implantation of (31)P(+) into p- wafers. The distinctive feature of these cells is that the (31) P (+) ion implantation was performed through a thermally grown silicon dioxide mask 100A - 700A thick. The expected impurity profiles of the implanted junctions were obtained through a first-order approximation of the implant/anneal processes. The dependence of the electro-optical characteristics of fabricated devices on the implant parameters is emphasized.

Silard, Andrei P

Solar Cells 15,3; November 1985; 211-223 (13p)

**060 Photoelectrochemical Behaviour of RuS(2) Semiconducting Electrodes.**

In this work some properties such as dark current, quantum efficiency for charge carrier generation and band gap value for sintered and monocrystalline RuS(2) photoelectrodes are explored. Estimated band gap values for the sintered electrode are 1.5 eV for the direct transition, 1.8eV for the indirect transition and 2.3eV for the monocrystal. The stability of the electrodes has also been tested. A careful study of the sintered electrode is reported; the shape and time evolution of the photocurrent are examined as a function of solution pH and the onset of the applied potential. The evolution of the potential of the photocurrent peaks is analysed with respect to the solution pH and the sweep. The kinetics of the photocurrent are determined for different potentials of the electrode.

Redon, A.M.

**061 Photoelectrochemical Cell Studies with Semiconductor Electrodes - A Classified Bibliography (1975-1983).**

The coverage of this bibliography spans a nine-year period (1975-1983) and lists over 1300 literature references. The coverage includes all semiconductor studies designed for the direct conversion of electricity and for the production of chemical fuels/industrial raw materials or by-products. Classification is based on chemical composition. Studies of dye sensitization of semiconductor electrodes are also listed in one section.

Kalyana Sundaram, K.

Solar Cells 15,2; October 1985;93-156(64p)

**062 Photoelectrochemistry of p-HgCr(2)Se(4) and p-CdCr(2)Se(4).**

The title semiconductors were examined particularly in Fe(III) TEA - complex and [Cr(III) EDTA](-1) redox solutions. For p-HgCr(2)Se(4), a maximum carrier collection efficiency of 70% was obtained as short circuit and the maximum monochromatic power efficiency was 2.5% (1% polychromatic). The p-CdCr(2)Se(4) was inferior in performance to p-HgCr(2)Se(4) in both redox solutions. Band gaps and flat band potentials were determined and location of the band edges is discussed.

Becker, Ralph S and others

Solar Energy Materials 12,5;November 1985;371-381(11p)

**063 Polythiophene-GaAs p-n Heterojunction Solar Cells.**

Thin layers of poly (3-methylthiophene) have been grown on n-type GaAs substrates. The p-type character of the undoped polymer leads to the formation of a p-n heterojunction. The reported heterojunction differs from organic-on-inorganic structures in that most of the incident light is absorbed within the GaAs substrate and not in the polymer front layer.

Horowitz, G and Garnier, F

Solar Energy Materials 13,1; Jan 1986;47-55(9p)

**064 Properties of Isotypical n-ZnS-n-GaAs Heterostructures Obtained by Chemical Deposition from Hydrous Solutions.**

It is shown that n-ZnS layers can be deposited on monocrystalline n-GaAs substrates by low-temperature chemical deposition from hydrous solutions.

Kulish, V.M. and others

Applied Solar Energy (Geliotekhnika) 21,1;1985;14-16(3p)

065 Simple Analytical Model for Calculating the Photo Response of Preferentially Doped Poly Crystalline Solar Cells.

A simplified three-dimensional analytical model is developed in order to simulate the effect of preferential doping along grain boundaries on the photo response of columnar-oriented fine-grain polycrystalline diffused solar cells. Calculations of the photoresponse and its dependence on the preferential doping are performed in order to determine the conditions under which the preferential doping becomes electrically active.

Ragaie, Hani V.

Solar Cells 15,1; September 1985; 51-59 (9p)

066 Sol-Gel Double-Layer Antireflection Coatings for Silicon Solar Cells.

Double-layer thin films of  $\text{SiO}_2$  and  $\text{TiO}_2$ , applied using the sol-gel process, were utilized as antireflection coatings on silicon solar cells. When coated with these films, the efficiency of a solar cell was increased by 44% which agrees well with the measured increase in cell solar absorbance of 47%. Modeling of the reflectance properties of the coated cells, using thickness and index of refraction values determined from ellipsometric measurements, was in excellent agreement with the spectral reflectance properties measured from 300 to 1100nm.

Pettit, R B and others

Solar Cells 15,3; November 1985; 267-278 (12p)

067 Stability Criterion for Tunnel Diode Interconnect Junctions in Cascade Solar Cells.

Studies the degradation due to high temperature annealing of the peak current of  $\text{p}^+ - \text{n}^-$  tunnel junctions in GaAs. Such junctions are intended for use as inter-cell ohmic contacts in cascade solar cells. The current degradation is a consequence of the broadening of the tunnel junction space charge caused by dopant diffusion. It is shown that the peak current is correlated with the dopant concentration profile of the linearly- graded junction. To avoid serious degradation of the peak tunnel current, the product of the larger diffusion co-efficient of donor or acceptor and time at high temperature must be less than  $1 \times 10^{-12} \text{ cm}^2$  and impurity diffusion length shorter than 10nm. This criterion is also applicable to materials other than GaAs.

Haynes, RE and others

Solar Cells 15,3; November 1985; 231-238(8p)

068 Temperature Characteristics of Solar-Array Modules.

A method of protecting photovoltaic converters in domestically manufactured solar arrays is analyzed. The method, which takes into account the possibility of natural cooling, involves placing

the converters in cylindrical tubes, which are filled with various gas heat carriers and then soldered.

Strebkov, D.S. and others

Applied Solar Energy (Geliotekhnika) 21,1; 1985; 20-21(2p)

**069 Temperature Dependence of Electrophysical Parameters of Germanium Photogenerators at High Illumination.**

The temperature characteristics of high-voltage germanium photo converters of matrix type are discussed.

Strebkov, S.S., Tikhomirova, V.A. and Fedosova, G.B.

Applied Solar Energy (Geliotekhnika) 20,5; 1984; 8-13(6p)

**070 Thin films of Mercury Cadmium Telluride for Solar Cell Applications.**

Electroplated CdS/pHg(1-x)Cd(x)Te (MCT) thin-film solar cells with  $(1-x) < 0.2$  are evaluated and compared with electroplated CdS/p-CdTe devices. It is shown that the series resistance limitations commonly observed in CdS/p-CdTe devices can be appreciably reduced if p-CdTe is replaced by p-MCT. This is due to the lower resistivities attainable in p-MCT thin films which in turn reduce both bulk and contact resistances. The possibility of bandgap control in MCT makes it an important candidate material for the production of high-efficiency tandem cells.

Basol, Bulent M and others

Solar Cells 15,3; November 1985; 279-84(6p)

**Photochemical Conversion**

**071 Anodically Oxidized Titanium Films to be used as Electrodes in Photoelectrolysis Solar Cells.**

Special titanium dioxide films which proved to be useful photoanodes for energy-harnessing reactions have been prepared by anodic oxidation of titanium plates in unusual conditions (strong alkaline solutions, very high current densities). The films showed n-type semiconducting properties, even before any reduction treatment, in contrast with what occurs to films obtained following conventional preparation techniques. The photoelectrochemical properties of the films have been determined by measuring the current-potential characteristics, the spectral response and the differential capacitance. The results are discussed together with the potentialities of the applied anodization technique, and the further development of the research are outlined.

Bicelli, Peraldo. L and others.

Hydrogen Energy Progress V: Proceedings of 5th World Hydrogen Energy Conference, Toronto 15-20 July 1984, edited by T N Veziroglu and J B Taylor, New York, Pergamon Press, 1984, v3, 1055-1065(11p)

872 Photoelectrochemical Performance of Anodic n-TiO(2) Films Submitted to Hydrogen Reduction,

Heat treatments at high temperature in a hydrogen-controlled atmosphere to which our titanium dioxide films, were submitted with the purpose of improving their activity for photoreaction are referred. In addition, preliminary results on water photoelectrolysis experiments on the same films are reported.

Bicelli, Peraldo L and Razzini, G.

Int J Hydrogen Energy 10,10;1985;645-649(5p)

873 Surface Characterization of Anodic Titanium Dioxide Films for Photo Electrochemical Solar Cells.

Three different titanium dioxide films have been prepared by anodic oxidation of titanium and their morphology, structure and surface composition are examined, the latter by ESCA analysis. A mutual relationship has been found between the presence of metal atoms, such as sodium in the bulk of the material and its response in photoelectrochemical cells.

Bicelli, Peraldo L and others

Solar Energy Materials 13,1; Jan 1986;25-35(11p)

874 Temperature Dependence of Photoelectrochemical Cell Power Parameters.

The temperature functions of the efficiency and fill factor of a photoelectrochemical cell (CVC) were studied. The cell had a photo electrode made of polycrystalline CdSe in a sulfide-polysulfide electrolyte. It was found that the nature of the temperature dependence of FECC power parameters is determined by the functions of  $I_o$ ,  $R_s$  and  $R_{sh}$  vs. temperature.

Vas'ko, A.T. and others.

Applied Solar Energy (Geliotekhnika) 21,1; 1984;9-13 (5p)

### Solar Thermal Power Systems

875 Efficiency of Incorporating Heat Accumulators in Solar and Combined Solar-Thermal Electric Power Stations

It is found that increase in turbine power above the optical-system power of the station is possible in a solar-thermal electrical power station with a large effect.

Akhmedov, R.B. and others

Applied Solar Energy (Geliotekhnika) 20,5; 1984;32-36 (5p)

**076 Land Requirements for Solar Electricity Alternatives.**

A review of existing and proposed solar electricity installations reveals a very wide range of land (or water) surface areas that would be required to produce a standardized 100 MWe. These range from under 1000 acres (400 ha.) for waste-to-energy plants, pumped storage, and parabolic dishes and troughs, to over 10,000 acres (400 ha.) for standard hydroelectric reservoirs, OTEC, solar chimneys and both cultivated and non-cultivated biomass. In addition, qualitative changes to the land must also be considered.

Pryde, Philip, R.

Geographical Dimensions of Energy. edited by Frank J. Catzonatti and Barry D. Solomon, D. Reidel, 1985, 255-275 (21p)

**077 Performance of Low Temperature Solar Rankine Power Generation System.**

The overall performance of a solar thermal electrical power generation system is governed by the performance of the energy collection system and the power conversion unit. Based on factual experience on the design and operation of a low temperature solar thermal electrical power generation system using flat plate collectors and an organic Rankine power unit with Freon-114 as the working fluid, an analysis was done for the insolation and ambient data for Kuwait. These results were applied to predict the optimum energy collection temperature and the best possible overall efficiency of the total system under different operating conditions.

Ayyash, S and others.

Energy Research 9,2; Apr-June 1985; 141-149(9p)

**078 Solar-Water-Storage Electric Power Station: Features, Potential and Prospects for Profitability.**

The prospects for combined solar-water-storage power stations for hydro units built in the Southern USSR have been discussed. One probable setup of a SWSES has been described. Refining the cost-benefit indices of such a SWSES entails the separate and detailed estimation of the energy and agricultural components and the establishment of the level of profitability of the new power plants for the specific conditions of the Southern USSR.

Aparisi, R.R. and others

Applied Solar Energy (Geliotekhnika) 20,5; 1984; 37-41(5P)

**079 Tower-Type Solar Electric Power Stations: Composite Solutions.**

A system of general composite characteristics of solar electric power stations (SEPS) of tower type required for the analysis and synthesis (optimization) of SEPS components is proposed and analyzed.

Teplyakov, D.I. and others.

Applied Solar Energy (Geliotekhnika) 20,6; 1984; 28-32(5P)

## Using Solar Energy in Steam Turbines.

Three steam-turbine designs using a liquid boiling at low temperatures as the working medium are considered. The working media used are the most widespread low-boiling liquids in practice: ammonia, Freon-12 and Freon-22.

Merchanskii, V. D. and Orlov, A. Yu

Applied Solar Energy (Geliotekhnika) 20,6;1984;19-23(5p)

## Space Heating And Cooling

### 1 Comfort Limits for Asymmetric Thermal Radiation.

Groups of 32 and 16 subjects of both sexes were exposed in an environmental chamber to radiant asymmetry caused by a cool wall, a warm wall and a cool ceiling. For cool walls, warm walls and cool ceiling, curves have been established showing the percentage of dissatisfied subjects as a function of radiant asymmetry. Radiant asymmetry at a warm wall caused less discomfort than at a cool wall. A cool ceiling caused less discomfort than a warm ceiling. Accepting that 5% of the subjects may feel uncomfortable, a radiant temperature asymmetry of 10 C is allowable at a cool wall, 23 C at a warm wall and 14 C under a cool ceiling.

Fanger, P.O. and others

Energy and Buildings 8,3; August 1985;225-336 (12p)

### 2 Engineering Method of Calculating the Heat Insulation of the Outer Walls of Buildings Combined with Solar Air Heaters.

A method of calculating the thickness of the warming layer in the outer wall of a building combined with a solar air heater for summer conditions of use is described, an example of calculation is given.

Turulov, V. A. and Khrustov, B.V.

Applied Solar Energy (Geliotekhnika) 20,6;1984;52-56(5p)

### 3 Evacuated-Tube Directional-Radiating Cooling System.

A new type of radiative cooling system is described. The radiator makes use of nonimaging optics and evacuated-tube technology to radiate significant amounts of heat to the 3K environment of outer space. The nonimaging optics are used to direct the radiation overhead, through the most transparent part of the 8-13 um atmospheric window. The required optimal concentration is small, and relatively simple mirror geometrics are possible. The evacuated-tube technology is used to attain storage temperatures at or below the freezing point, even when dewpoint temperatures are well above the freezing point.

Hull, John R and Schertz, William W

Solar Energy 35,5;1985;429-434 (6p)

**084 Optimal Control of Auxiliary Heating of Passive-Solar-Heated Buildings.**

Describes the development of optimal control strategies for the operation of this auxiliary heating system. The temperature in the residence throughout the day as determined by computer simulation is presented for several optimal and conventional control strategies. The optimal control strategies improved the temperature control in the building compared to the conventional strategies. All strategies were shown to depend heavily on weather prediction. Computer simulations showed that errors in weather prediction had a small effect on heating cost and a large effect on being able to maintain the desired indoor temperature.

Winn, Robert C and Winn, Byron C.

Solar Energy 35,5;1985;419-427 (9p)

**085 Passive Cooling in Hot, Arid Regions in Developing Countries by employing domed roofs and reducing the temperature of Internal Surfaces.**

Natural ventilation due to wind effects through buildings employing domed roofs was estimated by a flow network analysis. Through a one-dimensional energy analysis the inside surface temperature of a horizontal slab was estimated for various slab materials and thicknesses and external and internal conditions. The inside surface temperature was compared with the case of employing a roof pond. It was found that lower temperatures can be obtained by evaporatively-cooled moist internal surfaces than that which can be obtained by unshaded roof ponds.

Bahadori, MN and Haghighe, F

Building and Environment 20,2;1985;103-113(11p)

**086 Selected Passive Cooling Strategies: A Generic Economic Analysis for Office Buildings.**

Several passive cooling strategies are the basis of a generic economic assessment for the design of one and ten-story office buildings in 11 U.S. climate centers. Annual dollar savings in electricity bills are computed and a cash flow analysis quantifies the comparative attractiveness of the various cooling concepts. A measure of economic attractiveness - the investment target - provides an upper bound for affordable systems.

Roach, Fred and Mangeng, Carolyn

Passive Solar Journal 2,2; 1983;81-89(9p)

## 007 Simulation and Performance of Five Air Type Solar Heated Farm Buildings.

The construction and energy collection features of five types of solar heated farm buildings constructed at the Arkell Research Station near Guelph, Ontario, Canada are described. Instrumentation data acquisition, operating characteristics and performance of these buildings are also discussed. The average daily collector efficiency of different collectors varies between 0.205 and 0.545. The number and type of glazing layers, the number of airflow passages, leakage rate, shape and slope of collector, and collector area per unit volume of building are responsible for the collector performance variations. Observed heating load and solar energy contribution were compared with predicted values using F-CHART computer program.

Mittal, G.S. and others

Int. J. Energy Systems 5,2:1985:51-56(6p)

008 Systematic Approach to Solar Energy Use in Populated Areas.

A method of forming residential solar structure is described. Enumerates the steps involved in optimisation of residential solar-energy structure.

Minchuk, V.I. and Ponornarev, S.V.

Applied Solar Energy (Geliotekhnika) 21,1,1984,58-63(6p)

## 089 Wing Walls to Improve Natural Ventilation: Full-Scale Results and Design Strategies.

Natural Ventilation can be used to cool buildings during many months of the overheated season. A significant design problem arises in ventilating rooms which have only one external wall and therefore, cannot be normally cross ventilated. Architectural projections called wing walls can be used to effectively ventilate these rooms. The benefit of wing walls from air flow measurements in a full-scale room with and without wing walls is confirmed. Alternative design strategies for incorporating wing wall features in residences are also described.

Chandra, Subrato and others

Passive Solar Journal 2,2; 1983;116-122(7p)

## Solar Water Heaters

## 890 Developments in Solar Water Heaters.

This investigation reports various design concepts of solar water heaters for intermittent use and a new concept of continuous water supply. These systems have common features; they are without water tubes on the collector surface and without water pumps or a separate storage tank. The work highlights technical difficulties

encountered in the designs and upgrades the state of the art in solar liquid heaters by proposing and testing different prototypes for a long period of time.

Sorour, M.M.

Energy Convers. Mgmt 25,3;1985;365-372 (8p)

**091 Effect of Aging on a 22-Year-Old Solar Water Heater.**

Collector thermal performance tests on a 22-year-old double-glazed black painted solar water heater indicate that the degradation in its performance is due mainly to glazing seal failure allowing moisture into the insulation. The effect of dirt on the covers does not appear to have adversely affected its thermal performance.

Proctor, D and Czarnecki, J.T.

Solar Energy 35,2;1985;175-180(6p)

**092 Revolutionary Geyser Pump Collector.**

The Geyser pump operates by a new process that Haines patented in 1984. This collector functions automatically by using a simple check valve to prevent backflow. The Geyser pump only uses the phase change to pump the system and standard heat exchanger transfers sensible heat from the solar loop to the water in the storage tank, just as in any closed-loop antifreeze system. And it does all this for only \$20 to \$40 more per collector at manufacturing costs.

Adams, Jennifer A

Solar Age 10,10; October 1985;20-22 (3p)

**093 Thermal Performance Tests of a Solar Thermosyphon Domestic Hot Water Systems in Dhahran, Saudi Arabia.**

Primary objectives were to determine system daily solar fraction and thermal efficiency which were found to be 77.5 and 31% respectively. Secondary objectives were to determine the recovery rate in the storage tank for solar plus electric input and for solar alone which were found to be 2.7 and 6.3h respectively. The collector array efficiency was 55% for the 1-day test.

Abdelrahman, M.A.

Solar & Wind Technology 2,3/4;1985;149-153 (5p)

**Miscellaneous Solar Applications**

**094 200m(3)/Day Solar Sea Water Desalination Pilot Plant.**

A pilot plant was constructed in Yanbu, Saudi Arabia to test and demonstrate the world's first and largest solar sea water desalination pilot plant using the indirect freezing technology for the desalination system with 18 powerful point focus solar

collectors to provide energy to the system to produce 200m(3)/day of fresh potable water. Preliminary results indicated the usefulness of those two new technological applications meeting 75% of the baseline design values.

Khoshaim, Bakr H

Solar & Wind Technology 2,3/4;1985;173-182(10p)

**095 Basin-Type Solar Distillation with Air Flow through the Still.**

The energy balances for basin-type solar distillation with air flowing through the still have been derived. The effects of G (dry air flow rate per unit still area) and tw-to (tw=water-surface temperature; to = air temperature at the outlet) on the modified factor F have been investigated experimentally and a correlation equation derived. Considerable improvement in productivity may be obtained if the water vapor is carried away directly by the flowing air.

Yeh, Ho-Ming and Chen, Lie-Chaing

Energy 10,11; 1985;1237-1241 (5p)

**096 Design Construction and Test Run of a Solar Powered Solid Absorption Refrigerator.**

The intermittent system used CaCl(2) and NH(3) as absorbent and refrigerant, respectively. The absorbent was mixed with 20% by weight of CaSO(4), as cement, and prepared as hard porous granules of 5-10mm sizes. The double glazed collector/absorber/generator unit used clear PVC and plane glass sheets, with the former as the outer cover. A stagnant water evaporative condenser was designed and constructed of re-inforced sandcrete, with steel condenser tubes and was coupled to the system. Ambient temperatures during absorption and generation ranged over (25 C -35 C). Tests indicated that cooling capacities of the NH(3) condensed were around 714KJm(-2), while effective cooling obtained was equivalent to an ice production of 1kgm(-2) per day

Iloeje, OC

Solar Energy 35,5;1985;447-455 (9p)

**097 Performance of Series Solar-Assisted Heat Pump Systems in TECH House 1.**

The system performance factors measured over two heating seasons of 2.42 and 3.16 compare favorably with both standard active solar systems with heat pump systems. The improved performance in the second year is the result of increased insolation rather than the change to ground coupled storage. Conventional heat pumps cannot take advantage of the higher supply temperature to the evaporator because of design limitations. Improvements in heat pump design are possible to give increased performance.

Reid, R.L. and others.

**098 Solar and Heat Pump System - Horsens Swimming Bath, Denmark.**

Recently at Horsens, a combined solar system and heat pump system has been constructed together with a centralized control and supervision system. The solar system consists of 300m<sup>2</sup> flat plate solar collectors without cover glass and insulation. The heat pump system consists of two water-to-water heat pumps with a total effect of 70kW. The energy plant has given a saving of 2.8TJ (670 Gcal) from district heating in the first year which allowing for a use of electricity of 187MWh, amounts to a total of 14000 pounds (DKr 195000).

Esbensen, T and others

Int. J. Ambient Energy 6,4; October 1985; 201-204(4p)

**099 Solar Salt-maker.**

A system of making salt from sea water which is being used in the Philippines has been described. This design of salt maker can produce upto seven kilograms of cooking - quality salt in a two or three day drying period.

Archer, G.

Appropriate Technology 12,2; September 1985; 30(1p)

### Solar Collectors

**100 Analysis of the Sanyo Evacuated Tube Solar Collector Test Results from the IEA Task III Programme.**

Testing of a set of Sanyo STC-CU250 evacuated tubular collectors and subsequent data reduction has shown that large variations in thermal performance characteristics can result among a collector type taken from a production batch. The differences cannot be attributed to climatic variation as was done in previous intercomparisons.

Proctor, D and James, SR

Solar Energy 35,5; 1985; 387-392(6p)

**101 Analytical Model for the Integrated Daily Performance of Solar Air Heating Systems.**

An Analytical Integrated Daily Performance Model (IDPM) is developed to predict the long term performance of solar air heating systems. The IDPM is compared to simulation using a fully mixed model of storage and a single-phase model of storage. The comparisons show that the IDPM is more accurate than the mixed model and requires considerably less computation time than simulations using the single-phase model. In addition, the IDPM identifies several parameters that are important to system performance but are not

easily identified by non-analytical analysis.

Hoerger, C.R.B and Phillips, W.F.

J. Solar Energy Engg. 107,4; November 1985; 308-314(7p)

**102 Combination of Flat Plate Solar Collectors of Different Performance.**

The analytical model presented in this paper makes it possible to obtain the optimum combination of differently performing flat-plate collectors, in order to maximize the economic benefit of liquid heating solar plants at different temperatures and under different operating conditions. The results justify that combined flat-plate collector systems present better techno-economic performance at high temperatures than single systems with single cover collector.

Arata, Adolfo A and Geddes, Richard W.

Int J Solar Energy 3,6;1985;355-371 (17p)

**103 Cylindrical Heat Receiver for Thermal Solar Energy Converters.**

Theoretical and experimental results of investigating a cylindrical heat receiver with secondary reflectors are presented. The experimental distribution of the incident flux over the heat-sensitive surface of a heat receiver with secondary reflectors is shown graphically. It is evident that at the beginning and end of the wall, there are deviations from the uniform radiant-flux distribution. This is because the conical secondary reflector does not ensure strictly uniform distribution of the incident flux over the heat-sensitive surface of the heat receiver.

Gaziev, U.Kh. and others.

Applied Solar Energy (Geolotechnika) 20,6;1984; 45-48(4p).

**104 Design Considerations for Flat-Plate-Photovoltaic/Thermal Collectors.**

Based on a computer simulation of flat-plate PV/T collectors that is applicable to a wide range of designs, the present work focusses on air-type collectors employing single crystal silicon PV cells. The results of the simulations; for PV cells covering greater than 65% of the total collector area, a selective absorber actually reduces the thermal efficiency when used with a gridded-back cells. The requirements for the low emissivity coating are an infrared emissivity of less than 0.25 and a solar transmissivity of greater than 0.85. The optimum combination for an air PV/T was found to consist of gridded back PV cells, a non-selective secondary absorber, and a high transmissivity/low-transmissivity cover above the PV cells.

Cox, C.H. and Raghuraman, P.

Solar Energy 35,3; 1985;227-241 (15p)

105 Determining the Basic Operational Characteristics of a Solar Thermostat in the Conditions of Full-Scale Tests.

A method of calculating a heat-receiver-heater and the volume of the heat-store is presented, together with the results of full-scale tests of a solar thermostat with stochastic variations of climatic factors. Analysis of the data obtained shows that, despite stochastic changes in climatic factors, the apparatus ensures the maintenance of the specified temperature conditions (+40°C) with an accuracy of up to +3°C. The energy capacity of the heat stoves allowed optimal temperature conditions to be maintained in the absence of solar radiation for 62 hours.

Gryadunov, A. F. and others.

Applied Solar Energy (Geliotekhnika) 20,5;1984;45-47(3p)

106 Edge Effect on Luminescent Solar Concentrators.

The light distribution along the edge of luminescent solar concentrators has been studied experimentally and theoretically. Regular polygons with various numbers of sides have been considered. The effect of the geometrical shape on the overall conversion efficiency is discussed.

De Cardona, Sidrach M and others

Solar Cells 15,3; November 1985; 225-230(6p)

107 Electrolytic-Coloured, Anodized Aluminium Selective Absorber Coating and its Optical Properties.

The technology and the optical properties of the selective absorber coating prepared on industrial pure aluminium or aluminium alloys by the anodizing and colouring method is described. Bruggeman effective medium theory and multilayer matrix technique are used to calculate the spectral reflectance of the coating in the wavelength range 0.3 to 20μm. The result shows that the theoretical value is approximately in agreement with the experimental data. The effect of morphology on the optical properties of coatings is also discussed.

Yu-Wen, Zhao and others.

Int J Solar Energy 3,4-5;1985;271-285(15p)

108 Influence of the Degree of Vacuum on the Thermal Characteristics of Cylindrical Solar Collectors.

Research was conducted on the extent to which the degree of vacuum influences heat losses (both convective and those due to conduction through the air) in the space between a collector and a transparent shield. The results of this work can be used to determine the optimum degree of vacuum with regard to the collector's characteristic dimension and its operating temperatures.

Baimatov, T

Applied Solar Energy (Geliotekhnika) 21,1;1985;39-42 (4p)

109 Infrared-Transparent Convection Shields for Radiative Cooling: Initial Results on Corrugated Polyethylene foils.

Radiative cooling to a temperature far below that of the ambience requires a new type of convection shield which combines high transmittance in the 8-13  $\mu\text{m}$  wavelength range with high non-radiative thermal resistance. A design with crossed layers of vee-corrugated high-density polyethylene foils has been investigated. Typical results were infrared transmittance upto 73% (measured on an infrared-imaging instrument) together with thermal resistance of  $1.1\text{m}(2) \text{ KW}(-1)$  (determined with a modified guarded hot-plate technique).

Nilsson, N.A. and others

Solar Energy Materials 12,5; November 1985; 327-333(7p)

110 Instability Associated with the Onset of Motion in a Thermosyphon.

A theoretical method is presented for the study of the onset of motion in a symmetrical natural circulation loop. A one-dimensional model is applied to describe the behaviour of the flow and linear stability analysis is used for the investigation of its stability. The results show there exists a critical modified Rayleigh number,  $R_c$ , below which the rest state is stable and any flow perturbation will decay. The same results have been obtained from a steady-state analysis, there is no steady-state solution when  $R < R_c$ . For a vertical loop composed of two parallel branches heated from below and cooled from above  $R_c=6$ .

Zuirin, Yoram

Int J Heat Mass Transfer 28,11; 1985; 2105-2111(7p)

111 Method of Measuring the Absorptance of Coatings.

A method is discussed for measuring the absorptance of coatings in the spectral range 0.4-25 $\mu\text{m}$ . The technique is based on the reflection method.

Mavashev, Yu Z and others

Applied Solar Energy (Geliotekhnika) 21,1; 1985; 45-48(4p)

112 Performance Analysis and Load matching for Tracking Cylindrical Parabolic Collectors for Solar Cooling in Arid Zones.

Line concentrating collectors are being used for heating and cooling. They use a small micro-motor to track the sun in its daily east-west cycle. Due to environmental problems in the site the tracking system has failed. Major design modifications are explained to run the system trouble free. The major concern for solar airconditioning systems is mainly after applying serious energy conservation measures and thermal insulation to the building. There is certain threshold value for system operation and below that limit the system should not operate or it will be wasting electrical energy, not saving it.

Osman, M.G.

Energy Convers. Mgmt.25,3;1985;295-302(8p)

113 Performance Analysis of a Solar Air-Conditioned Villa in The Arabian Gulf.

An integrated system utilising (a) a solar photovoltaic power system (b) a solar air heating and rock storage system and (c) a solar water heating, cooling and domestic water heating system has been designed, installed and tested in the KISR Solar house, Kuwait. The performance of the different solar energy systems is reported in terms of collector efficiency, solar energy contribution and the use of electrical energy to operate the solar equipment and of fossil fuels to back up the operation of the solar energy system.

Osman, M.G.

Energy Convers. Mgmt.25,3;1985;283-293 (11p)

114 Performance of a Salt-Gradient Solar Pond for Power Production.

An analytical model of the thermal behaviour of salt-gradient solar ponds is presented. The model is used to predict the performance of a solar pond intended for electric power production. The pond dimensions and heat extraction rate are optimized to achieve a high mean value and small amplitude of pond temperature. The upper convective zone is found to have a deleterious effect on pond performance. The optimum depth of the non-convective zone which maximizes the pond yield is presented. It is found that careful selection of the depth of the lower convective zone and of the amplitude and phase lag of the heat extraction rate can lead to a small value of the amplitude of the pond temperature fluctuations.

Hawas, M. M. and Elasfouri, A.S.

Energy Convers. Mgmt.25,3;1985;323-330(8p)

115 Progress on Solar Absorber Selective Paint Research.

It has been demonstrated that TSSP (thickness sensitive selective paints) can be produced by a variety of methods. The gravure print process has resulted in optical properties of Absorptance 0.90 and Emittance 0.10 at a cost of \$0.24/ft<sup>2</sup> for an adhesive foil product. The goals for TISP (thickness- insensitive selective paints) have not yet been reached; however, a number of techniques and processes have demonstrated significant performance advantages over flat-black paints.

Moore, Stanley, N.

Solar Energy Materials 12,6; December 1985;449-460(12p)

116 Single-Pass Open-Loop Solar Thermal Energy Systems : On Maximum Energy Delivery by Variable flow rate.

For single-pass open-loop solar thermal energy systems in which the flow rate can vary with radiation but is constrained to have a given annual average, an upper bound is derived for the yearly energy delivery. The sensitivity of this upper bound to climatic and collector characteristics is determined analytically and is illustrated by several numerical examples. The results derived are general in that they apply to all collector types.

Gordon, J.M. and Zarmi, Y.

J. Solar Energy Engg. 107, 4; November 1985; 273-276 (4p)

117 Solar Absorber Selective Paint Research.

According to this report, by mid-1982, the advanced thickness selective paint (TSSP) coating is expected to be producible under various factory conditions. Commercial exploitation is expected to follow as a function of market acceptance and supply and demand. A coating with Absorbance 0.9 and Emittance 0.1 at a material cost of 5 ft<sup>2</sup> may soon be a reality. Thickness-insensitive selective paint (TISP) coatings should be at the point of optimization soon. Selectivity of Absorbance 0.9 and Emittance 0.3 at a material cost of 6/ft<sup>2</sup> is expected.

Moore, Stanley W.

Solar Energy Materials 12, 6; December 1985; 435-447 (13p)

118 Study on the Structural Properties of a-Si(1-x) Sn(x): H Films prepared by rf Sputtering.

The structure of hydrogenated amorphous silicon-tin alloy films has been systematically investigated as a function of substrate temperature  $T_s$ . X-ray diffraction, ir absorption and other characterization measurements were performed. It is shown that most of the Sn atoms go into substitutional Si sites at  $T_s < 220$  C whereas a large fraction of B-Sn precipitates are formed at  $T_s > 220$  C. The hydrogen as an active chemical agent of the deposition process plays an important role in this structural change.

Guang-hua, Chen and others.

Solar Energy Materials 12, 6; December 1985; 471-478 (8p)

119 Surface Coatings for Radiative Cooling Applications: Silicon Dioxide and Silicon Nitride made by Reactive rf-Sputtering.

Coatings of silicon dioxide and silicon nitride were produced by rf-sputtering of Si in the presence of O<sub>2</sub> and N<sub>2</sub>. The sputter unit, for coating surfaces upto 0.5 x 0.5m<sup>2</sup> in size, is described. Spectrophotometric data were used to evaluate the complex dielectric function in the range 5-50um. The parameters specifying the radiative cooling performance was studied by computation for oxide/nitride bilayers on Al.

Eriksson, T.S. and others.

Solar Energy Materials 12,5; November 1985; 319-325 (7p)

120 Tempering Valve Effects on Solar System Efficiency.

A common practice in the active solar energy collection area is the installation of a tempering valve between the solar storage tank and a cold-water supply line. Improper installation of a tempering valve can result in significant system performance degradation. Two isolated cases (one in Utah and one in Illinois) have been discussed here, in case such system flaws are more widespread.

Newell, T.A.

Solar Energy 35,5; 1985; 417-418 (2p)

121 Testing of an Evacuated Tubular Collector with a Heat Pipe using the Fourier Frequency Domain.

An outdoor method for the testing of an evacuated tubular collector with a heat pipe under a variable insolation has been described. Based on a heat balance of the collector defined in the Fourier frequency domain a set of equations corresponding to selective values of the Fourier variable can be formulated. The main collector parameters such as the absorption-transmittance product, the heat loss resistance and the efficiency factor, follow from a least square approximation. Atleast two series of experimental measurements with a different fluid inlet temperature are required.

Kamminga, W

Int. J. Heat Mass Transfer 29,1; 1986; 83-90 (8p)

122 Thermal Performance Evaluation of Active and Passive Water Heat-Storage Schemes for Solar Energy Applications.

Two schemes of water thermal storage (active and passive) were designed and constructed from readily available materials. A dynamic computer model was developed to predict the thermal performance of the water thermal-storage systems under various charging and discharging conditions. The simulated results and measured data compared favourably and these results showed that the water thermal-storage systems responded well to step and fluctuating input temperature changes. The water thermal storage may be satisfactorily used in varied solar energy applications where energy storage is necessary.

Arinze, E. A. and others.

Energy 10,11; 1985; 1215-1223 (9p)

123 TiN Films prepared by Nitrogen Implantation on Ti-Coated Fused SiO<sub>2</sub>.

Properties of TiN films prepared by 8-38 KeV N(2+) ion implantations on Ti-coated (90-650A) fused SiO<sub>2</sub>) have been studied for heat mirror coatings. TiN films prepared by annealing Ti film in a nitrogen atmosphere and by sputtering were used as reference samples. The implanted TiN films had as good visible light transmittances as the films prepared by annealing but better than the sputtered films. The advantages of the nitrogen implantation in the preparation of TiN films are excellent adhesion and low preparation temperature.

Erola, M and others.

Solar Energy Materials 12,5; November 1985;353-359(7p)

124 Truncation of CPC Solar Collectors and its effect of Energy Collection.

Analytic expressions are derived for the angular acceptance function of two-dimensional compound parabolic concentrator solar collectors (CPC's) of arbitrary degree of truncation. Taking into account the effect of truncation on both optical and thermal losses in real collectors, the increase in monthly and yearly collectible energy is evaluated.

Carvalho, M.J. and others.

Solar Energy 35,5;1985;393-399 (7p)

125 Wind-Induced Heat Losses from Solar Collector Arrays on Flat-Roofed Buildings.

This paper presents data for convective heat transfer coefficients on the front surface of a free-standing array of solar collectors mounted on the flat roof of a low warehouse-type building and exposed to the wind. The data were obtained by testing a 1:36 scale model in highly turbulent nonuniform flows which simulated the natural wind. For typical full scale conditions, the heat transfer coefficients are substantially lower than those given by a commonly used correlation. The coefficients are only mildly sensitive to wind direction, location of the array on the roof and characteristics of the wind.

Kind, R.J. and Kitaljevich, D

J Solar Energy Engg. 107,4;November 1985;335-342(8p)

### Heat Storage

126 Identification of UA in Thermal Storage Devices : Two Methods.

Two methods are described for identifying the key overall fluid to storage material heat transfer product UA, and the degree of stratification, NI, for use in the analysis of storage test data.

One method, the generalised model approach, permits a wide range of non-linearities as well as arbitrary test initial and boundary conditions to be accommodated. The other method, simplified graphical method, demands high quality step response data.

Marshall, Richard

Int J Solar Energy 3,6;1985;341-354 (14p)

## 127 Organic Phase Change Materials for Thermal Energy Storage.

An economic installed thermal storage may be possible with medium priced, high latent heat organic materials suitable for low cost packaging i.e., those that are insoluble in water and unreactive with air and some of the common packaging films. A preliminary survey of 12 such organic materials with melting points in the range 10-43 C. Measurements of melting point, freezing point and the latent heats of melting and fusion are presented.

Feldman, D

Solar Energy Materials 13,1;Jan 1986;1-10(10p)

## 128 Thermochemical Storage of Solar Energy with High-temperature Chemical Reactions.

A new solar energy facility has been installed on the Chemistry Building of the University of Rome. The focusing system and a specially designed chemical reactor are presented. The thermochemical processes involved display characteristics more advantageous than the traditional systems (sensible heat, latent heat) i.e., high energy density (energy stored per unit of mass) and storage at room temperatures. These two features together with the fact that thermal insulation is no longer required during storage, indicate that these systems are excellent candidates for large thermochemical energy plants.

De Maria, G and others.

Solar Energy 35,5;1985;409-416 (8p)

## 17 WIND ENERGY

### 129 Algorithm for Algebraic Analysis of Windspeed Variations.

An algorithm for data analysis is described in which hourly wind speeds are decomposed into independent components to account for variations due to different sources of time effects.

Goh, TN and Eu, PS

Wind Engg. 9,2; 1985; 62-66 (5p).

### 130 Application of Wind Power to Irrigation in Brazil.

An investigation into the feasibility of using wind energy to displace diesel power for Irrigation for rice cultivation in the Rio Grande do Sul State of Brazil has been carried out. A 6m diameter two bladed Darrieus wind turbine was tested with two centrifugal pumps of differing discharge rates and achieved a peak overall efficiency of 16%. An 18m diameter turbine is now being built to drive an axial flow pump with which a higher overall efficiency is anticipated. The economic viability of such a system for irrigation would depend upon the economies that could be effected in fuel, maintenance and depreciation costs of the diesel sets.

Sadhu, D and Ocacia, G

Wind Engg 9,3;1985;137-148(12p)

### 131 Design and Construction of Innovative Flexible Rotor Systems.

Wind Energy Design Studies carried out within the framework of the Dutch National Development Programme show that it is possible to define a wind turbine design which reduces the price of the generated electricity with about 50% with regard to the price level of commercial wind generators. The influence of the flexible blade suspension on the bending moment in the blade root and on the yawing and pitching moments exerted by the rotor design with built-in power control system are presented.

Drost, L.F. and Follings, F.J.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 212-215(4p)

### 132 Dutch Autonomous Wind Diesel System.

An autonomous wind diesel engine having two variable speed wind turbines and a diesel generator set as its main components has been developed by the Eindhoven University of Technology (EVT). At this moment, this system is being tested on the wind turbine test site of the FCN near Petten.

de Bonte, J.A.N

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 685-689 (5p)

### 133 EGAT and Wind Energy for Electricity Generation Program.

The strategy of approach of EGAT toward the wind electricity is presented alongwith its achievement/ status and future outlook. Accordingly small scale demonstration, test and evaluation of some commercially available wind turbine generators (WTG) have been conducted as "In-house activity" while support to local institutes has also been realized. It has been concluded that the wind potential for generating electricity does exist in some coastal areas of Thailand. Most practical applications of the WTG may soon be realized in some remote areas/islands of Southern Thailand.

**134 Electrical Interconnection for Offshore Wind Energy Systems.**

The interconnection and transmission arrangements proposed during the Phase 1 Department of Energy study of offshore wind power are summarized and this is extended to examine how a 2GW array located 28-30 km offshore would be connected and operated. The factors likely to influence the type of generator for offshore applications and their impact on the design and operation of the electrical connection system are discussed.

Gardner, G.E. and Franklin, P.J.

Wind Engg 9,3;1985;171-179(9p)

**135 Evaluation of Loads measured at the two Swedish Prototypes.**

The main object of the project is to map loads and to verify the design calculations. The evaluation which covers different wind situations and modes of operation will also be used for updating the load specification. Most of this presentation deals with the method for evaluating loads on different parts of the turbine. Some of the project experiences are also mentioned.

Ganander, H

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-24 Oct 1984, 177-182 (6p)

**136 Experiences from the Commissioning and Operation of the Swedish 2MW WTS Prototype , Naesudden.**

The Wind Turbine Prototype Nasudden on the island of Gotland in the Baltic Sea is a 2MW horizontal machine. After 238 hours of operation a damage in the toothed coupling inside the gearbox occurred. The damage was caused by too weak a design. After a design change the machine was back in operation again 6 months later. By October 1, 1984 the machine has been in operation for 111 hours producing 1218 MWh to the network. The experiences from the period after the recommissioning are very good. The availability is close to 60% which is better than expected taking into account that it has been a running-in period.

Svensson, G

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-24 Oct 1984, 158-164 (7p)

**137 Flat Wind Energy Converters, in the Power Range 50-100KW Models Already Built, Operating Experience - Further Developments.**

A description of design and features for the two following models are given. (1) 68 KW three blades WEC, for connection to the grid (2) 50 KW two bladed, controlled pitch WEC, for connection to the

grid. The operating experience on these models is then summarized. A short presentation of the follow up i.e., a 100KW two bladed WEC and an industrialized version of the 68 KW WEC, actually under development, is finally presented.

Vidossich, G.

European Wind Energy Conference Proceedings Hamburg, F.R.Germany, 22-26 Oct.1984, 115-118 (4p).

#### 138 Floating "WAGNER-ROTOR" concept and first experience.

The "WAGNER-ROTOR" is a hybrid between horizontal and vertical-axis turbines and gains the advantage of both. The WAGNER-ROTOR has proved as land based rotor and as seabased rotor. The experience in building and testing for the first floating WAGNER-ROTOR on a 160t experimental ship shows, that floating windmills could be a way to exploit sea wind.

Wagner

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984,222-224(3p)

#### 139 Further Development of the Swinging-Blade Savonius Rotor.

Savonius rotor performance is improved by allowing both downwind and upwind rotor blades to swing back through an optimum angle. This will minimize the drag on the upwind blade and maximize the drag on the downwind blade. A combination of 50 degrees upwind blade swing angle and 13.5 degrees downwind blade swing angle have been found experimentally to be the optimum swing angles that increased the rotor maximum power coefficient to about 23.5% compared with 18% with optimum upwind blade swing alone.

Aldoss, Taha K and Najjar, Yousef S.H.

Wind Engg 9,3;1985;165-170(6p)

#### 140 GROWIAN Test Program with Particular Respect to the Wind Distribution across the Rotor Area.

The comprehensive test program for the GROWIAN wind energy converter started in spring 1984. This report gives an overview of first results that were obtained during roughly 100 hours of rotational operation and 15 hours with grid connection with an energy output of 26,000 KWh since setting in operation. Results and experiences from a special wind measuring arrangement consisting of two 170m meteorological towers with brackets reaching out laterally are shown.

Besel, G and others

European Wind Energy Conference Proceedings Hamburg, F.R.Germany, 22-26 Oct 1984,197-202(6p)

141 Horizontal Axis Wind Turbine after 8000 hours of Operation.

A 25m horizontal axis wind turbine at the Netherlands Energy Research Foundation, Petten, The Netherlands, is now in operation for three years. Relevant operational experiences (including those during a maintenance period), turbine automatic control and a comparison of turbine behavior working under different control strategies, and results of the measurement programme are dealt with.

Dekker, J.W.M. and others

European Wind Energy Conference Proceedings Hamburg, F.R.Germany, 22 Oct 1984, 190-196(7p)

142 Improved Design of Wind Towers for Natural Ventilation and Passive Cooling.

A design is proposed to improve the performance of wind towers (or Baud Geers) for natural ventilation and passive cooling. Under similar climatological and design conditions, the new design is capable of delivering air to the building at higher flow rates. It can also cool the air evaporatively to lower temperatures. Momentum, mass and energy analysis are carried out for the proposed design. The results are presented in graphical forms which may be used as guidelines for employing the design for specific applications in the hot arid areas of the world. An example is worked out to show the use of the results.

Bahadori, Mehdi N.

Solar Energy 35, 2; 1985; 119-129(11p)

143 Innovative Control and Safety Systems for Water Pumpers.

Essential for the economic viability of water pumping wind mills is a low-cost, reliable and effective control and safety mechanism. The basic ideas of a model describing the static and dynamic behaviour of the control mechanism is presented. The results of different ways of analysing and solving the complicated, non-linear, differential equations involving a great number of parameters is compared to preliminary experimental results obtained in the wind tunnel of the Eindhoven University of Technology.

Smulders, P.T. and others

European Wind Energy Conference Proceedings Hamburg, F.R.Germany, 22 Oct 1984, 746-754 (9p)

144 Introduction of Tip Vane Augmenters onto a Horizontal Axis Wind Turbine.

A wind turbine needs to be designed carefully to extract the energy from an incoming wind stream in an economic manner. The application of tip vane augmenters to a 2m diameter scale model turbine was investigated. High levels of drag masked net power improvements. Identifying the sources of drag, an improved arrangement was developed, tip vanes being mounted on power blades designed to match the augmented air flows. For a combination of tip vane and

blade settings, performance curves were established. Levels of performance were improved over the earlier arrangement and a marginal improvement was demonstrated over the performance of the new power rotor run alone. General performance however, is less than may be expected from an unaugmented rotor.

Garside, A. J.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 216-221 (6p)

145 Inventory and Evaluation of Experience made with SWECS in Western Germany.

The objective of this work on behalf of the German Ministry of Research and Technology was to win an overlook on the existing SWECS in Western Germany, their qualities and their efficiency, as well as their economy. Professionally built units were minority among home built ones. The amateur windmills are generally of low technical standard and their output of small value. Many of them stand in zones of insufficient wind speed. The legal regulations officially restrict the use of SWECS, in some areas they are practically of a prohibitive character.

Stephenson, Walter and Bohmek, Georg

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 203-211 (9p)

146 Investigation of Interaction between a Simulated Wind Turbine and a Pump.

A wind turbine is simulated by a DC motor and coupled to a centrifugal pump and the steady and transient characteristics of the coupled system are investigated. A mathematical model for the transient characteristics of the coupled system, using the principle of conservation of energy and the steady state characteristics of the wind turbine and the pump is proposed. The experimental method is described and some of the results presented.

Nathan, G.K.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 735-739 (5p)

147 Momentum Analysis of Tornado Wind Energy Concentrator Systems.

The momentum theory is applied to the tornado wind energy concentrator system. It is shown that the power coefficient of the system can be written as a product of three factors: a mass concentration coefficient, an energy augmentation coefficient and an extraction coefficient. By this splitting the relative importance of the three components in the power output of the system can be analysed. Extrapolation of the characteristic coefficients for large scale systems is possible leading to a performance prediction for real applications.

Dick, E

Int. J. Energy Systems 5,2;1985;42-46(5p)

148 Operating Experience with a 300 KW Aerogenerator designed for Remote Locations.

James Howden and Co.Ltd. have erected and commissioned a 300 KW aerogenerator on the North of Scotland Hydro-Electric Board Site at Burgar Hill in the Orkney Islands. This paper describes the experience gained during erection and commissioning and the operation of the turbine connected to the system is reviewed. Problems encountered since commissioning are described.

Brown, A. and Stevenson, W.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 165-169 (5 p).

149 Optimal Use of Wind and Diesel Generation On a Remote Scottish Island.

This paper describes the operational experience with a 50 KW wind turbine generator and associated equipment commissioned on Fair Isle in June 1982. Although not designed to operate in parallel with existing diesel generators the control system is such as to optimise, as far as practicable, the use of both means of generation. The wind turbine generator was the first unit to be operated on a commercial basis in the U.K.

Stevenson, W.G. and Somerville, W.M.

European Wind Energy Conference Proceedings Hamburg, F.R.Germany, 22-26 Oct 1984, 681-684 (4p).

150 Optimization of the Performance of the Variable Pitch Vertical Axis Wind Turbine.

The optimized performance of a two-dimensional variable pitch Vertical Axis Wind Turbine (VAWT) is investigated using two different theoretical models, the multiple streamtube model and a vortex model. The influence of tip speed ratio, solidity and Reynolds number on the optimal pitch variation is calculated and the corresponding performance curves are produced. Comparison is made with the results of the VAWT without pitch variation and with sinusoidal pitch variation at different amplitudes.

Zervos, A and others.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 411-416(6p)

151 Optimum Configuration Studies, Prototype Design and Performance of a Savonius Rotor Based Irrigation System.

Describes evolution of a wind energy operated irrigation system from model tests in wind tunnels, for optimization of system parameters

to a prototype prepared for field tests. The ultimate objective is to emphasize simplicity in design and ease of maintenance using infrastructure readily available in rural areas of developing countries. In particular, it attempts to meet irrigation requirements of small farms approximately 4-6 acres in size, in Indonesia.

Modi, V. J and others

European Wind Energy Conference Proceedings Hamburg, F.R.Germany 22-26 Oct 1984, 740-746 (6p)

#### 152 Performance and Operational Data from the Orkney 20M Diameter WTG.

Data from the monitoring program presently underway on the Wind Energy Group 20m, 250Kw wind turbine is reported and compared with equivalent predicted data. Power production, dynamic loads, aerodynamics and noise are addressed.

Garrad, A.D. and others

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 170-176 (7p)

#### 153 Post Stall Studies of Untwisted Varying Aspect Ratio Blades with NACA 44XX Series Airfoil Sections \_ Part II.

Presents the post stall aerodynamic characteristics, lift, drag and pitching moment, of untwisted constant chord blades as a function of airfoil thickness, aspect ratio and Reynolds number. This data is helpful for the design of cost effective wind energy conversion devices. The results presented give a fair representation of the aerodynamic ramifications of operating in deep stall conditions.

Ostowari, C and Naik, D

Wind Engr 9,3;1985;149-164(16p)

#### 154 Progress with the U.K. Vertical Axis Wind Turbine Programme.

Describes the current status of the UK Vertical Axis Wind Turbine Project Construction of a 25 metre diameter prototype variable geometry machine which is currently underway at Carmarthen Bay Power Station in South Wales. The progress on site and at the various manufacturing centres is illustrated. Design aspects of the rotor transmission, civil and electrical systems are discussed. The eventual aim of the project is the construction of multimegawatt vertical axis wind turbines and studies have been carried out to investigate siting such machines offshore. Work in this area is also presented.

Mays, I.D. and Rhodes, H.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 130-137(8p)

## 155 Report from WTS - 3 Maglarp, One Year of Operation.

The wind turbine WTS - 3 at Maglarp has been in continuous operation since the acceptance on September 22, 1983. The unit has been operated by the utility company SYDKRAFT as a conventional power plant unmanned and under remote control. The experiences of first year of operation are good. The wind turbine shows good availability power performance and the cost of operation and maintenance is reasonable considering it is a prototype and first generation of large scale WECS. The environmental impacts are causing problems in two areas- TV interference and Acoustic noise.

Agrelli,M

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 152-157(6p)

## 156 Requirements for Wind Turbine Safety Systems.

The Netherlands Energy Research Foundation (ECN) has assessed wind turbines with respect to environmental safety and (to some extent) hindrance. This paper describes the requirements for wind turbine safety systems used in this process. These requirements, together with design criteria have been brought into the Dutch Normalization Committee for wind turbine (NEC-96).

Stam, W.J.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 333-335 (3p)

## 157 Research and Development for Shrouded Wind Turbines.

In order to exploit the wind power as economically as possible, it was suggested that the wind turbine should be enclosed inside a specially designed shroud. It is shown that up to 80% improvement in the shroud power augmentation can be obtained by the use of an appropriate ring-shaped flap while proper bleeding of the shroud's external flow into its inner rear part will increase its power augmentation by about 25%. Based on the research with shrouds, a pilot plant producing 1 hp at 5m/s with a 3m diameter turbine was built. Its preliminary test results are also included in the review.

Igra, O

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 236-245(10p)

## 158 Research on Wind Energy at B.U.E.T.

Realising the potential of wind energy in Bangladesh a group in the department of Mechanical Engineering started some activities in this area. Three different types of rotors - Savonius rotor, Sailwing rotor and Darrieus rotor were designed, fabricated and installed to study their performances. These rotors have been described here.

Kanti Das, Dipak

159 Residential and Agricultural Application of Wind Energy.

Output of wind turbines, economics of wind energy application, test reports on basic component of wind turbines i.e. wind turbine rotors and pumps are discussed. Six wind turbines - Sail Rotor Wind turbine, Wooden Rotor Wind turbine, Galvanized Steel Sheet Blade Wind turbine, multi-blade wind turbine, Bamboo-blade Wind turbine and Laminated Wood-blade Wind turbine are discussed.

Suwantragul, Banterng

160 Stochastic Analysis of Wind Stream and Turbine Power.

Stochastic analysis of a high -frequency wind data tape has been performed. The tape includes wind speed and direction as well as wind-turbine -generated power. This analysis forms the basis for data collection procedures for initial site evaluation and full-scale machine power predictions.

Lou, Jiann-Jong and Corotis, Ross B

161 The 15m Vertical Axis Wind Turbine Pioneer I. Description and Experiments.

In spring 1982 an experimental vertical axis wind turbine has been installed at Amsterdam. Preliminary electrical performance measurements have been carried out by means of a mini-computer based data acquisition system. Results (P-V curves) presented including corrections of the average wind speed for the distance between anemometer and wind turbine. Also the analysed losses in drive train and conversion system are presented. A more comprehensive data acquisition system based on a PDP 11/23 computer will be operational soon and enable remote control of turbine operation and measurement system. The applied data acquisition system also is described together with the intended measurement programme.

Machielse, L.A.H.

162 Transient and Steady State Modelling of a Coupled WECS.

The paper presents a method for simulation of a wind turbine using a DC motor. To verify the method of simulation an American multiblade wind turbine is chosen, loaded by coupling to a centrifugal pump. Using the principle of conservation of energy and characteristics of both constituent units two mathematical models are proposed, one for steady state operation and another for transient state. The close comparison between the theoretical and experimental results

validates the proposed models and the method of simulation.

Nathan, G. K. and Tan, J.K.

Wind Engg 9,2;1985;76-87(12p)

#### 163 Transient Behaviour of a One-Bladed Horizontal-Axis Wind-Turbine.

Aerodynamic and dynamic modelling techniques of the WEC, the development of control strategies for the transition into/out of nominal performance as well as simulations and measured time histories with emphasis on transient operating conditions, are presented. It is concluded that for the prediction of transients, which are relatively problematic operating phases of the supercritical, one-bladed wind turbine concept, the modelling of classical, stationary rotor aerodynamics is sufficient, but an exact description of the control system is needed.

Wennekers, R.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 183-189(7p).

#### 164 Use of Windpower in Autonomous Reverse Osmosis Seawater Desalination.

Mathematical models of three wind-powered reverse osmosis seawater desalination plants are described. Each model describes a manner by which a reverse osmosis plant can deal with the variability of wind power. An economic assessment of all three plants is given by the optimisation of the reverse osmosis plant capacity and the wind turbine area.

Feron, P

Wind Engg 9,3;1985;180-199(20p)

#### 165 What is the Most Economical Size for a Large Wind Power Plant?

The question of the most economical size for a large wind energy converter designed to feed the power into a large utility grid and therefore without limitation of the output with respect to the consumer, is an issue of controversial debates. In analysing the problems, facts as production status, assembly and erection costs, O&M costs, and energy production with increasing size are considered. It is concluded that the most economical size for a large WEC strongly depends on the numbers produced and operated. For the nearest future - with the expectation that only small numbers of larger WECs come to a commercial application - the economical size of a rotor diameter seem to be in the range of 50-60m.

Hau, E

European Wind Energy Conference Proceedings Hamburg, F.R.Germany, 22-26 Oct 1984, 820-825(6p).

## 166 Wind Electric Pumping Systems.

Presents the design procedure of water pumping windmills where a wind generator is directly coupled to a electric pump. The procedure is assessed by comparing the theoretical expectations with the outcome of a field test. The feasibility of these systems is presented in a comparison with diesel pumps.

Goezinne, F and Eilering, F

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-23 Oct 1984, 730-734(5p)

## 167 Wind Energy Conversion Systems..

The successful harnessing of wind power source depends on two main factors, the first one is to have a detailed and extensive wind measurement programme at national level, and secondly to either develop or select Wind Energy Conversion Systems (WECS) to match the local wind regimes. The selection of WECS developed in one country may not be the best suited for another. Due consideration to the local conditions should be given. Finally, the greater acceptance of WECS for various applications would depend on producing WECS which are fool proof and that could survive the severest of weather conditions to which WECS are often subjected too.

Nathan, G. K.

Int J Energy Heat Mass Transfer 7,3;1985;225-235(11p)

## 168 Wind Energy Estimation and Siting in Complex Terrain.

The currently available algorithms for predicting the wind field in rough terrain for potential wind power estimation have been examined. Numerical codes have been divided into kinematic mass-consistent flow field ones that do not explicitly utilize the momentum equation and dynamic ones that solve the full set of environmental fluid mechanics equations appropriate to meso scale regions.

Lalas, Demetrius P.

Int J Solar Energy 3,2; 1985; 43-71 (29p).

## 169 Wind Energy for Pumping Irrigation Water.

Wind power alone normally has difficulty in supplying all the energy needed for irrigation during these peak water-use periods. However, with wind-assist pumping systems, sufficient water is supplied and electrical energy or diesel fuel is saved. Electrical wind-assist pumping systems provide sufficient energy for irrigation pumps of the same size with excess energy available in all months except July & August. Wind diesel pumping systems reduce fuel consumption by 30 percent when used from March through October.

Clark, Nolan R

170 Wind Power Potential of Saudi Arabia.

Wind data for 20 locations in Saudi Arabia have been analysed. Monthly and annual mean wind speeds and wind powers have been determined. The latter range from 2.5 to 4.4 m/s and from 21.8 to 77.7 Wm(-2) respectively. Specific outputs from two hypothetical aerogenerators with rated wind speeds of 5 and 7 m/s have been estimated. Examples of monthly mean wind speed and wind power temporal variations are given. Results suggest that wind power would be more profitably used for local and small-scale applications.

Martin, Ph.

Solar & Wind Technology 2,3/4;1985;139-142 (4p)

171 Wind Powered Water Pumping: Comments on System Design Illustrated by Examples from Africa.

A choice has to be made regarding the correct size of turbine diameter and pump-and water-storage-capacity to ensure complete provision for the drinking-and domestic-water for a remote community at a given site and with a given consumption pattern or to provide for the irrigation of fields. The system behaviour was simulated therefore by means of computer program FWISO 81 using hourly weather - and consumption data. The results show that for the complete provision of the community ( $v=2.3\text{m/s}$ ) 2 wind-powered pumps and a storage capacity of 0.6 days are necessary and to cover the requirement for irrigation needs ( $v=5.1\text{m/s}$ ) 3 wind-powered pumps and a two-day storage capacity.

Auer, F.

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 724-729 (6p)

172 Wind Tunnel Study of the Tornado Wind Energy System.

Results of tests in  $1.75 \times 1.75$  open wind tunnel on logarithmic spiral shaped Tornado towers and on omni -directional towers with straight vanes are presented. Tower models of different sizes were tested in order to determine the Reynolds effect. This allowed the performance prediction for large scale systems.

Haers, F and Dick, E

European Wind Energy Conference Proceedings Hamburg, F.R. Germany, 22-26 Oct 1984, 481-486 (6p)

173 Wind Turbine Driven Boat.

This paper describes an experimental wind turbine drive which has been fitted to a small boat. The main features of this design and the modes of operation are described along with an explanation as to how the design was developed. The importance of the efficiency and

power ratio values in predicting the performance of a wind turbine propelled vessel is explained. Variations of the step-up ratio from wind turbine to propeller and in size of propeller and their effect upon performance are explored. Drag and driving force predictions are also presented.

Bose, Neil

European Wind Energy Conference Proceedings Hamburg, F.R.  
Germany, 22-26 Oct 1984, 226-230(5p)

**174 Windmill Tip-Speed Ratio Regulation Using an Impedance-Matching Control System.**

A discussion of the approaches to, and benefits of windmill tip-speed ratio (TSR) control is presented. Rotational speed regulation via load-controlled impedance matching is identified as the most efficient control method. An all-mechanical, self-powered windmill TSR controller using this method is presented with a discussion of its operation and wind tunnel test results. A design methodology is presented and used to design a controller for a windmill driving an electrical generator and for the same windmill driving a water pump. These designs are verified with a digital computer simulation using real wind data. The simulation results also demonstrate the economic feasibility of the system.

Hendler J. and others

J. Solar Energy Engg. 107,4; November 1985; 326-334 (9p).

**20 ELECTRIC POWER ENGINEERING**

**175 Cooling for Vertical Heat-Generating Channels in Steam-Water Counterflows.**

Experimental research was conducted on a heat emission crisis when water is boiling in vertical tubes with one closed end. This crisis is the result of a hydrodynamic crisis ("flooding") of steam-water counter flows, which leads to a reduction in the flow rate of the downward flowing water in the channel. An equation is given for determining the time interval between the moment that flooding starts until the moment that the surface temperature of the heat-generating channel begins to rise. A calculated function for determining the critical thermal flux is given and compared with experimental data.

Ilyukhin, Yu N and others

Soviet Energy Technology(Energomashinostroenie) 1;1985;6-13(8p)

**176 Econometric Assessment of Power Pooling**

Summarizes the results of an on-going econometric assessment of power pooling and is the first electric scale study to include demand pattern variables. Includes four power pooling variables and shows that prior estimates of electric utility long run average costs and optimal scale have been biased by their absence. The pooling results indicate the absence of generating cost and reserve margin savings from power pooling.

Huettner, David C

Int. J. Energy Systems 5,2;1985; 66-70(5p)

**177 Electrical Safety in Hazardous Environments.**

An overview of the requirements for electrical equipment in potentially explosive atmospheres is given. Flame-proof, intrinsic safety, increased safety, non-sparking, pressurization, purging, special protection and flame arrestor methods of protection are all described. The method by which equipment can be shown to be safe in a whole range of gases, by testing in a single test gas, is described. Direct and indirect methods of overload protection for increased-safety motor are compared and it is shown that valuable production time can be unnecessarily lost when overcurrent protection is used.

Grantham, C

Int. J. Electrical Power & Energy Systems, 7,4; October 1985, 194-200(7p)

**178 Influence of Long-Term Steam-Turbine Operation on the Properties of Rotor and Casting-Part Material.**

The mechanical properties and heat-resistance characteristics of the metal in standard rotors and cast casing parts were determined after various periods of operation (22,000-198,000 hours). The stability of the service properties of R2 and R2MA rotor steels and 15Kh1M1FL casing steel during long-term steam-turbine operation was determined. The sum total of the data obtained during research on rotor and casing-part metal after long-term operation show that these steels have sufficient service-property stability. Therefore, steam turbines can be operated beyond their calculated service life.

Anfimov, V.M. and others

Soviet Energy Technology (Energomashinostroenie) 12, 1984; 21-24 (4p)

**179 On-line Optimal Dispatch: A Knowledge-Based Approach.**

This paper presents a new method for the on-line optimal dispatch of real and reactive power generations. Rather than using standard iterative algorithms, the approach is based on recognizing similarities with previously studied situations and on using similar samples to linearly predict the optimal generator settings. This approach greatly simplifies the on-line computational burden. For practical applications the differences between the predicted and optimal values are quite acceptable. Large errors can be avoided by controlling the degree of similarity with the base samples.

Napoli, R and others

Int. J. Energy Systems 5,3;1985; 95-99 (5p)

## 29 ENERGY PLANNING AND POLICY

### 80 Application of the Expenditure Function in Electricity Pricing: Optimal Residential Time-of-Use Rate Option.

This paper derives the optimal electricity prices when a customer can choose between paying the TOU rates and full incremental costs of a TOU meter and remaining on a flat rate schedule. In the model described consumer surplus is seen as the difference of two expenditures evaluated at the original flat rate and the new rate schedule (which may be flat or TOU) chosen by a customer according to a self-selection rule. The following section solves the optimization problem and presents the optimal pricing rules. It restates these rules with the help of measures of customer price responsiveness. The concluding section summarizes major findings and discusses the validity of this analysis in the context of the residential market in Northern California.

Woo, Chi Keung

The Energy Journal 6,2;April 1985;89-99(11p)

### 181 Appropriate Technology Information Clearing House.

The Research Centre for Applied Science and Technology (RECAST) established in early 1983 an Appropriate Technology Information Clearing House under RECAST/UNFSSTD Project in order to serve as an information resource for those seeking technical information for solving local problems. The objectives, functions, capability & resources, clearinghouse network and the staff of the clearinghouse have been dealt with in this article.

Tribuvan University, Research Centre for Applied Science and Technology Recast/Unfsstd Project, Kirtipur, Kathmandu, Nepal.

Rec J Energy Heat Mass Transfer 7,3;1985;221-224(4p)

### 182 Consequences of Energy Developments: An Approach to Assessment and Management.

Explores relevant ideas of organizational and political analysis so as to outline the context of decision making on energy issues. Comprises of case studies of four countries, which provide a detailed look at the development of energy projects and methods and data used in impact analysis, against the background of the diverse technological and institutional settings. Provides a comparative perspective on decision systems in four countries characterized by various degrees of political pluralism.

Lakshmanan, TR and Johansson, B

Large -scale Energy Projects: Assessment of Regional Consequences  
edited by TR Lakshmanan and B Johansson (studies in regional science  
and urban economics v12), Amsterdam, Elsevier, 1985, 1-24 (24p)

183 Economics of Business Investments in Renewable Energy Systems.

Investigates the economic conditions under which renewable energy systems become cost effective for a business. Three renewable energy technologies - photovoltaic systems, wind generators and small-scale hydroelectric plants are discussed. The emphasis of the study is on determining the impact that renewable energy system investment tax credits, operation and maintenance, and system lifetime have on the economics of a renewable energy system. The study is limited to commercial sized systems (about 100 kilowatts) which are treated as a business investment.

Schoemackers, Rudi and others.

Int. J. Energy Systems 5,2;1985;47-50 (4p)

184 Electric Power in ASEAN Countries: A Shifting Fuel Mix.

This article describes how the ASEAN countries are shifting the pattern of their fuel mix for electric power generation from oil to other sources of energy, with a preference for domestic energy resources. Singapore, which has no indigenous energy resources, is the single exception. Data from Brunei are not yet available.

Kadir, Abdul

Energy 10,12;1985;1277-1282(6p)

185 Electricity Pricing for Conservation and Solar Energy Systems.

Discusses some basic electricity concepts such as use or load patterns, costs and rates. Presents criteria for a sound rate structure, and examines the justifications for and limitations of declining-block rates. Analyzes the cost and conservation justifications for, and implementation of time-differentiated pricing.

Uhler, Robert G and Malko, Robert J.

Economics of Solar Energy and Conservation Systems Vol.1, edited by Frank Kreith and Ronald E. West; Florida, CRC Press, 1980, 198-214 (16p)

186 Estimate of the Price Effect of Competition : The Case of Electricity.

Estimates the effects of direct electric utility competition on consumer prices. The data are from cities where two electric firms compete for the same customers. Multiple regression analysis shows that substantially lower prices evolve in competitive situations. The results provide a measure of the effects of monopoly on the prices consumers pay and an assessment of the effects of competition as a regulator of utility rates of municipal utility firms.

Primeaux, Walter J

Resources and Energy 7,4; December 1985; 325-348 (16p)

187 Estimating Industrial Energy Demand with Firm-level Data: The Case of Indonesia.

An understanding of the effect of raising energy prices on the Indonesian manufacturing sector could be achieved if estimates of own and cross-price elasticities for individual fuels were available. This paper avoids the time-series data constraint by making use of firm-level sample survey cross-section data. These data, containing information on the operation of thousands of manufacturing firms permits the estimation of production structures with five energy inputs for 27 manufacturing subsectors.

Pitt, Mark M

The Energy Journal 6,2; April 1985;25-39(15p)

188 Future Direction for Load Management.

It has been concluded that although load management programs have been successful in reducing peak electrical demand, future program must be designed to: 1) fill valleys as well as shave peaks and 2) give customers more choice about the way they consume energy. With the operation of the Diablo Canyon and the Helms Power Projects, PG and E's projected generation capabilities will increase by approximately 3000MW. In the near future, not only will the threat of summer brownouts and blackouts be sharply reduced, but at times base-load capacity may exceed demand. Given these changes, load management strategies should be modified to induce customers to buy more off-peak energy.

Falk, Jill and Harris, Steve D

Meeting Energy Challenges. Proc. of the 2nd Great PG&E Energy Expo  
1985, Oakland, 21-23 May 1985, vi,123-133 (11p)

189 Gas Turbine Combined - Cycle Cogeneration.

Reviews the benefits and applicable considerations of gas turbine combined cycle cogeneration. Some basic issues that must be considered in the cycle selection process are Thermal Optimization, Financial Proforma and Demonstrated Economic Viability, High Fluctuating Thermal Load with constant Electrical Output, Pressure letdown applications and Additional System Complexity Considerations. A discussion on these issues is presented.

Viera, S

Meeting Energy Challenges. Proc of the 2nd Great PG & E Energy Expo  
1985, Oakland, 21-23 May 1985, v1,233-242(10p)

190 Improving Industrial Competitiveness - The Impact of Energy R&D.

The wider industrial impact of energy R&D programmes is generally misunderstood, with the result that their strategic importance is seriously underestimated. This paper indicates the important positive effects that energy R&D can have for more general aspects of industrial productivity and competitiveness and illustrates this

using examples drawn from European Community Energy R&D Programmes.

McMullan, J.T. and Strub, A.S.

Energy Research 9,2; Apr-June 1985;193-201(9p)

191 Latin American Energy Cooperation and its Extension to the other Developing Countries.

The experience of the Latin American Energy Organization (OLADE) in the field of energy cooperation is analyzed with the objective of presenting the Latin American region's opportunities for energy co-operation with other developing countries.

Cruz, Alejandro.

J Energy Development 10,2; Spring 1985;273-283

192 Long-term Expansion Planning for Hydrothermal Electric Power Systems.

Some aspects of the applicability of mixed integer programming (MIP) in expansion planning for regional electric utility systems, considering both power plants and the transmission network. The hydrothermal generation system may include significant run-of-river and reservoir power stations, and also pumped storage stations. Some essential elements of the model are explained to demonstrate the MIP modelling. The application of the model to the long term expansion planning problem of a hydrothermal power system is also described.

Rabensteiner, G.

Electrical Power & Energy Systems 7,4;October 1985; 225-228 (4p)

193 Principles of Economics Applied to Investments in Energy Conservation and Solar Energy Systems.

Focuses on the analyses required for making economically efficient choices among alternative energy conservation investments. Standardized approaches are provided that will be useful for a variety of energy conservation investment decisions. The emphasis is on practical methods of problem solving, rather than on theoretical discussions. The concept of economic efficiency, measurement of benefits and cost, commonly used techniques of economic analysis, their advantages and disadvantages are discussed. Factors that significantly affect benefits and costs are identified and discussed. A typical, but relatively simple life-cycle costing problem is presented.

Marshall, Harold E and Ruegg , Rosalie T .

Economics of Solar Energy and Conservation Systems Vol 1,edited by Frank Kreith and Ronald E.West, Florida, CRC Press,1980,125-173(49p)

194 Privatization - A New Concept of Private Financing for Municipal Energy/ Utility Projects.

Reviews and discusses certain forms of "privatization" transactions. It is seen that privatization of municipal utility projects and particularly energy related projects focuses on a very real working relationship between the public and private sectors which is beneficial to both. Three types of projects, focusing primarily on energy production, cogeneration and wastewater treatment facilities are described.

Casselman, Kirk J

Strategic Planning and Energy Mgmt. 5,1;1985;27-40(14p)

195 Quantifying Uncertainty in Energy Model Forecasts.

A method of quantifying uncertainty in energy model forecasts is demonstrated. Sensitivity testing procedures that have been developed and tested over the past four years and used in the analysis of several different types of mathematical models, have been used in this demonstration. A medium size energy model developed for analysis of electric utility issues has also been used.

Ford, Andrew and McKay, Michael D.

Energy Systems and Policy 9,3;1985;217-247(31p)

196 Robustness as a Goal in Energy Models and Policies.

The use of robustness as a policy objective is examined with reference to future electrical generation in the province of Ontario and the difficulties in planned outcomes between the goals of cost minimization and robustness are discussed. The assumption is made of a linkage between energy models and policies to facilitate the use of robustness analysis. Examples of the form of this linkage are presented in the Canadian context.

Lonergan, S.C.

Energy 10,11;1985; 1225-1235(11p)

197 Short-and Long-run Marginal Cost Pricing: On their alleged equivalence.

The equivalence between short-run marginal cost (SRMC) and long-run marginal cost (LRMC) is valid only under the restrictive assumption that the capacity can be varied continuously. This means that indivisibilities, irreversibilities and durability of investments are ignored. Where such phenomena exist, as in electricity production and distribution, pricing according to LRMC is neither theoretically valid nor applicable. It is not surprising that it has been difficult for public utilities to define the LRMC concept operationally; average cost concepts are used as 'approximations.' Under these circumstances it is advisable to dispense with the LRMC concept altogether and rely on pricing based on SRMC.

Andersson, Roland and Bohman, Mats.

Energy Economics 7,4; October 1985; 279-288 (10p).

**198 Statistically Adjusted Engineering (SAE) Models of End-Use Load Curves.**

Models that combine engineering and statistical approaches to estimating customer-specific end-use load curves are developed and demonstrated. Simulated end-use loads from engineering methods enter as explanatory variables in statistical models and estimated parameters adjust the engineering loads on the basis of customers' observed loads. The resulting end-use loads, called statistically adjusted engineering (SAE) loads, depend on a variety of conditioning variables, including weather and the size and type of the customer's dwelling and income and other characteristics of the household. Using data from a Los Angeles sample of households, several SAE models are estimated that differ in the flexibility that allow in the adjustment of the engineering loads.

Train, Kenneth and others.

Energy 10,10;1985;103-111(9p)

**199 Technology for Load Management.**

In order to carry out effective load management programs, utilities define desired load shape objectives, identify loads that are suitable for cost-effective modification, and select implementation techniques to put in place load management technologies compatible with these loads and desired load changes. Alteration of the operating patterns of existing end-use appliances and equipment (load control) and installation of new end-use appliances and equipment with more desirable load characteristics (for example thermal storage and dual fuel heating systems) are the focus of load management. Load control and thermal storage are discussed in this paper.

Rabl, Veronika A

Meeting Energy Challenges. Proc. of the 2nd Great PG&E Energy Expo 1985, Oakland, 21-23 May 1985, v1, 169-178(10p)

**200 Trade-Offs for Conflicting Social Objectives in the Extraction of Finite Energy Sources.**

Three social objectives figure prominently in the extraction of finite energy resources, namely income maximization, environmental quality and inter-generational concern. Owing to lack of complementarity, the pursuit of these objectives often result in conflicts. As a result, extraction strategies should be based on the determination of trade-offs between the objectives. The paper deals with the formulation and illustration of a systems model to determine these trade-offs. The recognition of such trade-offs results in a greater conservation of the finite energy resource, and hence could act as an incentive for the development of alternative energy sources.

Thampapillai, Dodo J.

Energy Research 9,2; Apr-June 1985;179-192 (14p)

**201 Use Management Accounting to Plan and Control Your Energy Program.**

Explores the problems of current energy management techniques and outlines a planning and control method, based on costs, to correct them. It is concluded that energy consumption should be viewed as a cost of doing business and should be accounted for as such. With this energy cost perspective, an effective formal energy management system and a universally comparable performance reporting system can be developed. With this management approach, energy will receive the economic attention it requires.

Hanna, David

Strategic Planning and Energy Management 5,1;1985;16-26(11p)

**202 Using Cost of Electric Service Interruption Surveys in the Determination of a Composite Customer Damage Function.**

This paper presents summary results of a recent Canadian cost-of-interruption mail survey of residential, commercial (retail), small industrial and large user customer sectors. The variation of cost among the subgroups within the sectors is outlined. These cost-of-interruption results, together with findings of other studies are used to explore the concept of creating a composite cost-of-interruption function for a particular service area with a known customer mix. The application of such a customer damage function and its inherent strengths and weaknesses are discussed.

Wacker, G.

Int.J.Energy Systems 5,3;1985; 100-104 (5p).

**30 DIRECT ENERGY CONVERSION**

**Fuel Cells**

**203 Fuel cells.**

Reviews the applicability of acid electrolyte fuel-cell systems towards power generation for operating electric vehicles. The progress that has been made in the catalysis of methanol oxidation and oxygen reduction has been reviewed with emphasis on methanol electrode and those aspects of the air electrode of particular relevance to methanol-air fuel cells. The applicability of alkaline fuel cells as power sources for electric vehicles is reviewed. The electrochemical and material science aspects have been covered because the electrochemical cell is the heart of the fuel cell and determines the technical feasibility of such power plants.

Stonehart, P. and others.

Power Sources for Electric Vehicles:(Studies in Electrical and Electronic Engineering edited by B.D. McNicol and D.A.J. Rand, Amsterdam,.Elsevier, 1984,v11, 769-882.(114p)

**204 High-Temperature Fuel Cells for Power Generation.**

An analytical model of high-temperature solid-electrolyte fuel cell (HTSEFC) performance is described. The resulting numerical mode yields a detailed description of the electric potential distribution along the air and fuel electrodes of the HTSEFC. This information is used to determine overall HTSEFC operating performance as well as the various overvoltages which detract from such performance. The mode yields results that compare favorably with the published experimental data from Westinghouse

Wepfer, W. J. and Woolsey, M. H.

- Energy Convers. Mgmt 25,4;1985;477-486 (10p)

**205 Impedance Measurements of Air-Oxidized and H(2) Annealed Raney-Ni Catalysts for Alkaline Fuel Cells.**

The kinetic reactions at the three-phase boundary (electrolyte/catalyst/gas) is investigated by measurements of n-i characteristics and exchange current densities. In addition, impedance measurements were used to get further information on the oxidation kinetics of H(2) in H(2) electrodes of alkaline H(2)-O(2) fuel cells.

Brennecke, P. W. and others

Energy Convers. Mgmt. 25,4;1985;469-475(7p)

## 32 ENERGY CONSERVATION

**206 Study of the Operating Characteristics of a Water-Lithium Bromide Absorption Heat Pump.**

Performance data have been obtained on an experimental water-lithium absorption heat pump constructed largely from standard glass components for three concentrators of lithium bromide. The experiments which were carried out for a delivery temperature of 70 C show that the co-efficient of performance decreases and the temperature lift increases with an increase in flow ratio and an increase in the concentration of lithium bromide. Coefficient of performance between 80 and 90 percent of the theoretical maximum possible values were obtained.

Chaudhari, S.K. and others

J Heat Recovery Systems 5,4; 1985;285-297 (13p)

**207 Study of the Thermal Characteristics and Potential for Energy Conservation at Four London Office Buildings.**

Four office buildings have been selected to represent typical constructions over the last half century. Each has been simulated by the THERM computer program and accuracy of the models checked against actual fuel bills. By altering the computer models of the four buildings it has been possible to investigate various means of reducing energy consumption.

Bennett, J.R. and others

Building and Environment 20,2;1985;83-94 (12p)

